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ABSTRACT

This student guide is for Unit 3, Primary Circuit, in the Engine Tune-Up Service portion of the Automotive Mechanics Curriculum. It deals with how to test the primary ignition circuit. A companion review exercise book and posttests are available separately as CE 031 212-213. An introduction tells how this unit fits into the total tune-up service, defines new terms, and provides work activities on the introductory information. Eight performance objectives are covered: inspect points and condenser, remove and replace ignition points and condenser, remove and install the distributor, strobe the distributor and adjust advance mechanisms, overhaul and calibrate distributor, inspect and test primary circuit, remove and install coil, and remove and install ignition switch and resistor. Each objective is addressed in a separate section that includes these materials: introduction to the performance objective, performance checklist, list of tools and equipment needed to do the work activities for this performance objective, reading list, information sheets, and work activities that give hands-on practice in doing one part of the performance objective. (YLB)

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ENGINE TUNE-UP SERVICE

Unit 3: Primary Circuit

Student Guide

Automotive Mechanics Curriculum

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HOW TO USE THIS BOOK

As you work through this Student Guide, you'll find directions about when to do certain activities and when to use the Review Exercise Book. Be sure to follow these directions carefully since they lead you step by step to the completion of a performance objective.

Performance Objectives

The performance objectives (abbreviated P.O.) in this Student Guide are statements of what you'll need to do on the job. All the materials in the Student Guide and in the Review Exercise Book are carefully designed to help you do well on performance objectives. So be sure to complete all the activities and try to do well on each activity.

After you have finished the activities for a performance objective, your instructor will test you to see whether you have mastered the necessary skills. A performance checklist will be used to check your work. Each performance objective introduction includes a copy of the checklist. Be sure to read it so that you'll know exactly what you'll be tested on.

A list of tools and equipment that you will need is also provided in the introduction for each objective. If you want more information about a performance objective be sure to refer to the reading list in that introduction.

Work Activities

You'll need to check with your instructor before and after doing any work activity. Automotive mechanics is a hazar-
doing any work activity. Automotive mechanics is a haz-
ardous trade. That's why it's important for you and your in-
Each work activity gives you "hands-on" practice in doing one part of a performance objective. If you do each work activity as required in the Student Guide, you'll find it easier to do the complete performance objective later on. Never hesitate to ask your instructor about something you're unsure of in a work activity.

Review Exercise Book

As you work through this Student Guide, you will frequently be directed to complete a pretest or an exercise in your Review Exercise Book. Before you begin the first pretest, read the introduction at the front of the Review Exercise Book. The introduction gives you information about how to use the book so that you'll get the most out of it.

Pretest

Before you go any further, ask your instructor whether you can take the first pretest for Unit 3. The pretest will let you know what to look for in these materials. If you do well on the pretest, your instructor may let you skip some of the study material in the Student Guide.

Your instructor will let you know when to begin studying the materials in this Student Guide.

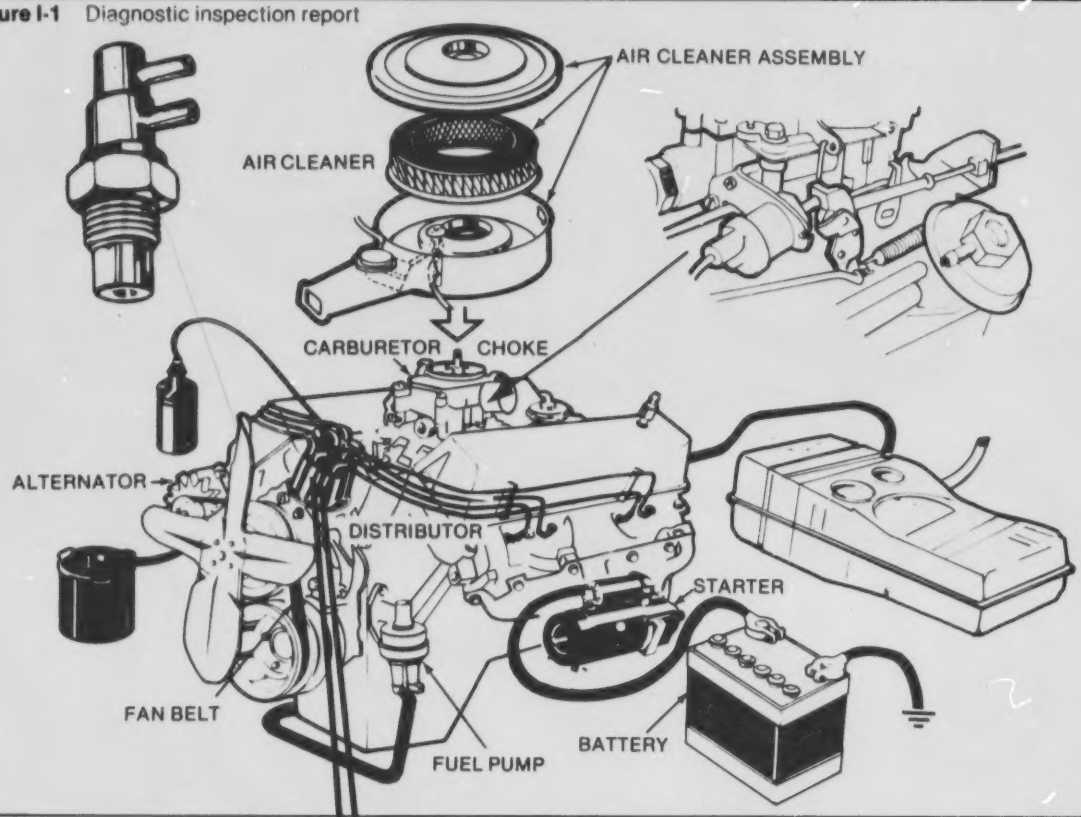
Good luck!

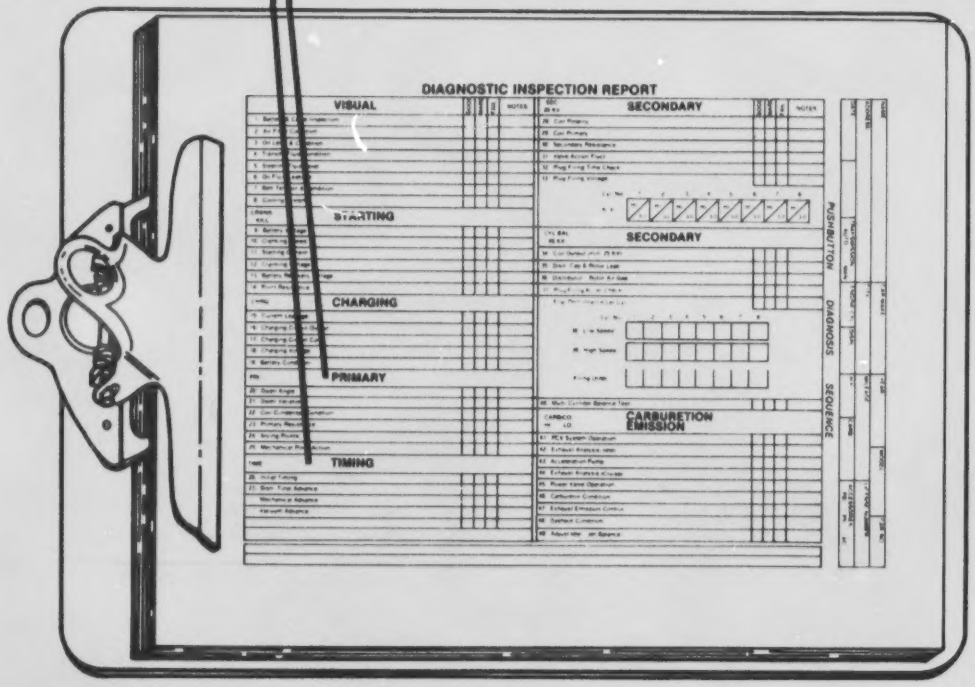
UNIT 3: PRIMARY CIRCUIT

INTRODUCTION TO UNIT 3

Testing the primary ignition circuit is the next step in total tune-up service (see Figure I-1). In this introduction to Unit 3, you'll learn what the primary ignition circuit is and how to identify the parts and wiring that make up the circuit. In the unit itself, you'll be learning how to adjust, repair, and replace the parts and wiring in the primary circuit.

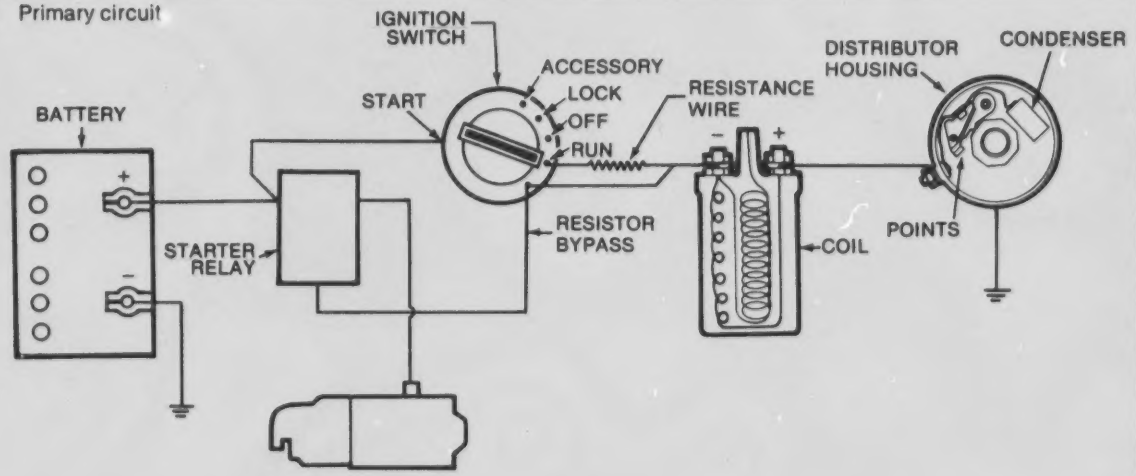
Figure I-1 Diagnostic inspection report





The vehicle ignition system is made up of two circuits: ***primary*** and ***secondary.*** The purpose of the ignition system is to step up the low battery voltage (12 volts) to about 25,000 volts in order to jump the spark plug gap. The primary circuit is the low-voltage (12-volt) part of the ignition system. It carries the low-voltage current from the battery to the coil and to the contact points in the distributor.

Figure I-2 Primary circuit



The primary circuit is made up of the following parts:

The ***battery***, which is the source of current and voltage.

The ***ignition switch,*** which controls the current flow in the primary circuit and energizes the cranking circuit to crank the engine (see Figure I-2).

The ***primary resistor,*** which is located between the ignition switch and the coil, and controls the amount of primary current in the ignition system when the engine is operating (with the ignition switch on ***run***).

The ***coil,*** which is the key part of all ignition systems. It is a step-up transformer where the low voltage (12 volts) is stepped up to approximately 25,000 volts. All of the primary circuit current flows through the primary winding of the coil.

The ***distributor***, which has three functions—

It opens and closes the ignition primary circuit (contact points).

It times the high-voltage charges with engine speed and load, advancing and retarding the spark (vacuum advance and centrifugal advance mechanisms).

It distributes high-voltage charges to the spark plugs in the correct engine firing order.

The ***contact points***, which are located in the distributor, and which combine with the distributor cam to make a rotating switch. When the contact points are closed, the primary circuit closes to allow the coil to build up voltage. When the points are open, the primary circuit opens and high voltage from the coil is delivered to the spark plugs.

The ***condenser***, which is located in the distributor near the contact points, and which prevents electrical arc damage to the points by absorbing continuing current at the points when they open.

The ***connecting wires***, which include both the battery cables and the wires leading to the ignition switch, to the primary resistor, to the resistor bypass, to the coil, and to the contact points.

Operating Principles

In addition to the ignition switch, the contact points in the distributor control the primary current in the primary circuit. When the contact points close the primary circuit, they allow the coil the necessary time to build up available voltage. Then, when the contact points open, the higher available voltage is discharged into the secondary ignition circuit.

When the ignition switch is in ***start***, the primary current bypasses the resistance wire and directs the higher voltage (12 volts) to the coil (see Figure I-2). This provides maximum primary voltage in the ignition system during starting. When the engine starts, the ignition switch is in ***run*** position. The primary current is then passed through the resistance wire.

New Terms

You need to know the following new terms for unit 3.

Ohms. The unit for measuring the electrical resistance of an electrical part.

Kilovolts (KV). A unit for measuring voltage (1 kilovolt equals 1,000 volts). It is used to measure spark plug gap voltage on engine oscilloscope test instruments.

Initial timing. Refers to timing the engine ignition at engine idle RPM.

Mechanical advance. An assembly in the distributor that controls timing advance according to engine speed.

Vacuum advance. An assembly in the distributor that controls timing advance according to engine speed and load (throttle opening).

Turn to your Review Exercise Book and complete Exercise 1.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

1. Draw a vehicle's primary ignition circuit and label all parts and wiring, including the circuit grounds. (pages 1-4) *Check your work with your instructor.*

2. Look at several vehicle engine primary circuits and identify the parts and wiring that make up the circuit. (pages 1-4) *Check your work with your instructor.*

After you have finished these activities, go on to the next section.

PERFORMANCE OBJECTIVE 8

INSPECT POINTS AND CONDENSER

INTRODUCTION TO P.O. 8

In this performance objective, you'll learn how to inspect the distributor contact points and the condenser.

After you have finished all the work activities for Performance Objective 8, your instructor will use a checklist like the one below to evaluate your work.

Performance Checklist—P.O. 8

The instructor will provide either a live vehicle or a live engine. Inspect the points and condenser. All of the performances below must be accomplished.

Student Performances

1. Removes distributor cap and rotor.
2. Visually inspects contact points, and notes any defects.
3. Tests points for resistance, and records results.
4. Checks point gap adjustment and alignment, and records results.
5. Tests contact point spring tension, and records results.
6. Visually inspects condenser and lead.
7. Tests condenser, and records results.
8. Replaces rotor and cap.
9. Uses proper tools and equipment.
10. Follows all appropriate safety precautions.
11. Performs tasks in an acceptable amount of time.

Instructor Ratings

Acceptable	Not Acceptable	Omit
SAMPLE		

Tools and Equipment

For this objective, you will need to use the tools and equipment listed below. You will be given the procedures for using special tools and equipment as you work through the activities.

Basic Hand Tool Set

Basic Equipment

contact point spring tension gauge
fender covers
extension light
remote start switch

Special Equipment

coil and condenser tester

Reading List

If you would like additional information as you work through this performance objective, use the references below.

General References

Crouse, *Automotive Mechanics,* pp. 296-97, 302-5.

Crouse, *The Auto Book,* pp. 259-69, 364-66.

Ellinger, *Automechanics,* pp. 272-95.

Stockel, *Auto Mechanics Fundamentals,* pp. 51-58.

Stockel, *Auto Service and Repair,* pp. (21-1)-(21-16).

Toboldt and Johnson, *Automotive Encyclopedia,* pp. 395-406.

Special-Purpose Reference

Crouse, *Automotive Electrical Equipment,* Ch. 12-13.

Personal and Service Safety Practices

Safety When Testing Contact Points and Condensers

Fender covers. Always use fender covers when doing work under the hood.

Clean area. Always wipe the distributor cap and surrounding area clean before removing the cap. This will prevent dirt from getting inside the distributor.

Personal safety. Avoid reaching into an engine compartment without looking first. Your fingers could get caught and cut by moving parts when the engine is cranking or operating.

Safety When Making an Electrical Test

Correct procedures. Follow the electrical test equipment manufacturer's procedures. This includes procedures for the proper care and use of the equipment as well as instructions for making important equipment calibrations.

Personal safety. Never do any electrical tests while standing on a wet floor surface or when the vehicle or engine parts are wet. A painful shock could result.

Be careful when attaching the remote starter switch leads, since battery voltage is present.

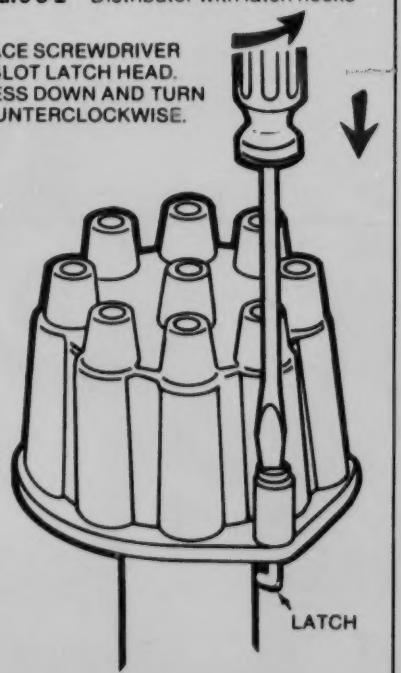
Safety in Work Clothing and Grooming

Jewelry. Avoid wearing any metal (rings, buckles, wristwatches, necklaces) that may come in contact with an electrical part. You can receive a severe burn.

Clothing. Avoid wearing loose clothing or anything that can hang down and get caught by moving parts when the engine is cranking or operating. Injury can result.

Figure 8-1 Distributor cap with spring clips

Figure 8-2 Distributor with latch hooks



REMOVING THE DISTRIBUTOR CAP AND ROTOR

Removing the Distributor Cap

To perform visual inspections and tests of the contact points and the condenser, the distributor cap must first be removed. In some cases, the distributor rotor will also have to be removed.

After you have gathered the proper tools and arranged the droplight so that the work area is well-lighted, do the following:

STEP 1 Wipe away any dirt found on or near the distributor cap. This will keep dirt from getting inside the distributor and fouling the operating parts of the distributor.

STEP 2 With your fingers, snap open the two distributor cap hold-down spring clips (see Figure 8-1). Press in at the center of the spring clips to open them.

CAUTION: *Do not* use a screwdriver to pry the spring clips open. You could accidentally break the distributor cap.

STEP 3 Some distributor caps use latch hooks to hold the cap to the distributor; there is one on each side of the cap. With a screwdriver, press down and turn the latch counterclockwise one-half turn. Do the same to the latch on the other side (see Figure 8-2).

STEP 4 Next, push up on the cap to disconnect it from the distributor housing. Then, to avoid damage to the rotor, lift the distributor cap ***straight up*** and away from the distributor.

STEP 5 Carefully place the distributor cap to one side. It may be necessary to remove the center coil wire or some spark plug wires to gain more room to work in. If you remove any wires, be sure to mark them first so that they can be put back into the same terminal.

Removing the Rotor

Remove the rotor if necessary. (On some distributors the rotors are removed in order to see the contact points better.) To do this, remove the rotor attaching screws, and lift the rotor from its mounting (see Figure 8-3).

NOTE: Some rotors fit on the top of the distributor shaft, as shown in Figure 8-4. To remove these rotors, work them up and off the distributor shaft.

Removing a Radio Frequency Insulator (R.F.I.) Shield

Remove the Radio Frequency Insulation shield if one is present.

Figure 8-4 Rotor on top of distributor shaft

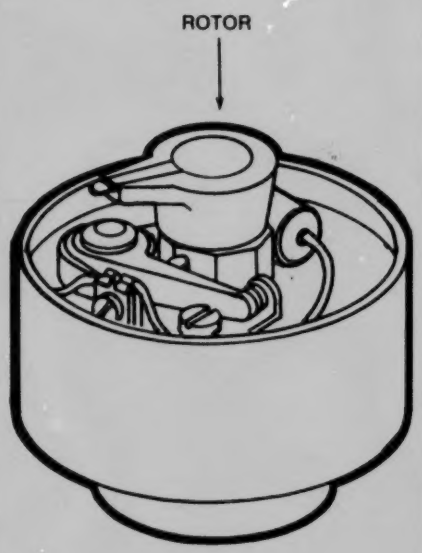


Figure 8-5 Removing R.F.I. shield

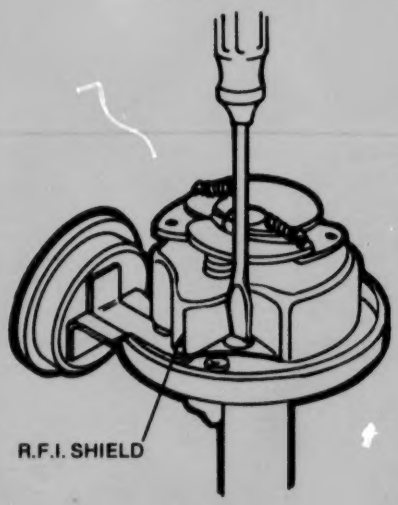
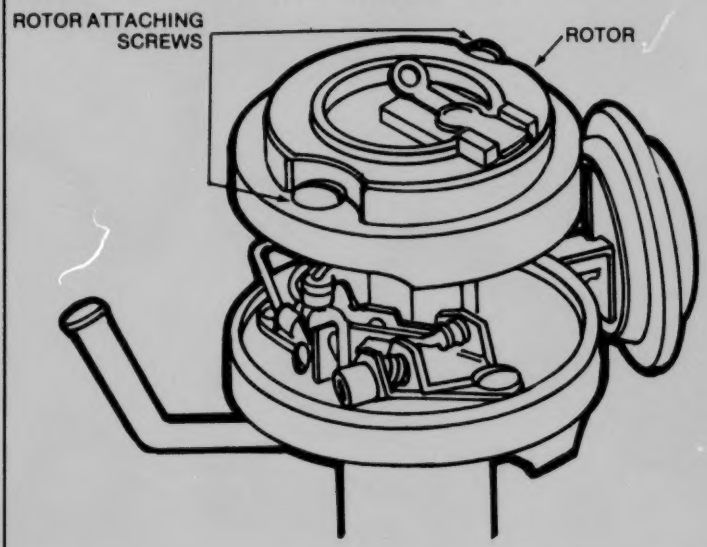


Figure 8-3 Attaching screws holding rotor in place

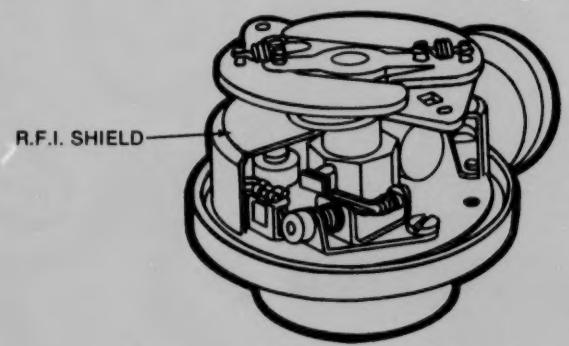


(This shield prevents radio static caused by operation of the distributor. A distributor with a conventional contact point set must always have a shield. The shield consists of two parts; one half is removed at a time.)

STEP 1 Remove the attaching screw and slide away the first half of the shield (see Figure 8-5).

STEP 2 Remove the second attaching screw and the second half of the shield.

Figure 8-6 Distributor with one-half of R.F.I. shield removed



Turn to your Review Exercise Book and complete Exercise 2.

WORK ACTIVITY

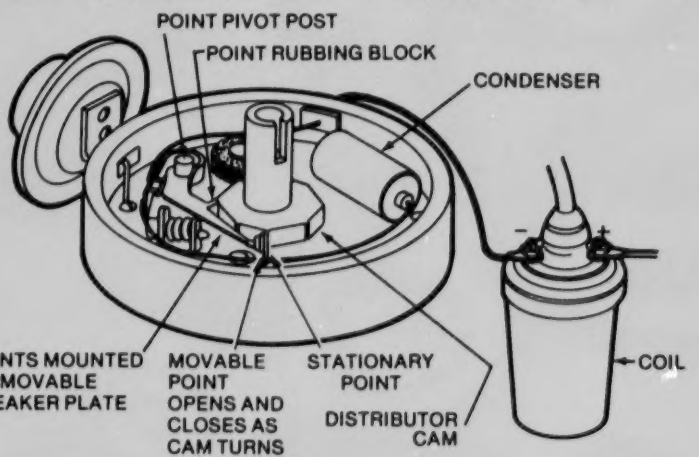
Do not begin this work activity until you have your instructor's approval. If you have any difficulty, review the pages listed next to the work activity. If you still have difficulty, ask your instructor for help.

1. Remove a distributor cap and rotor. (pages 11-12) *Check your work with your instructor.*

After you have finished this activity, go on to the next section.

LOCATION AND TYPES OF CONTACT POINTS

Figure 8-7 Location of contact points on breaker plate assembly



After removing the distributor cap and rotor, you will be able to see the contact points, the distributor cam, the condenser, and the movable breaker plate assembly. The contact points and condenser are attached to the breaker plate assembly (see Figure 8-7). The contact points are sometimes called ***breaker points***, ***distributor points,*** or ***distributor contact points.***

Notice that in a set of contact points there are two separate point assemblies. Each assembly has a ***point***, or contact. One point is on a movable arm that swings back and forth. It is referred to as the ***movable point.*** The pin that the arm swings or pivots around is called a ***pivot post***. The movable point rests against the distributor cam by means of a rubbing block. The other point or contact is on the ***stationary*** (nonmovable) point. It has a base that is firmly attached to the distributor breaker plate assembly.

The contact points together with the distributor cam make a rotating switch. Spring tension of the movable arm closes the points together so that an electric current can pass through them. Then, as the distributor cam rotates, it opens the movable point, which stops the flow of electric current.

Figure 8-8 Set of contact points

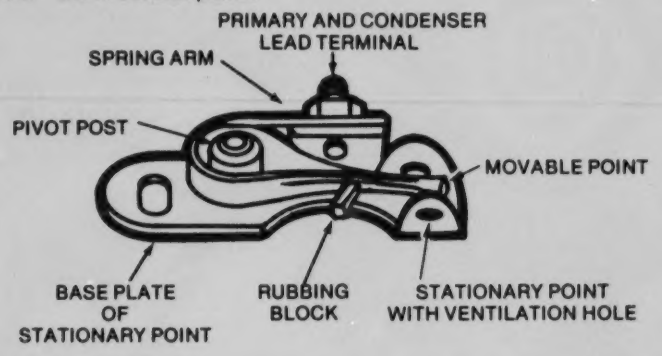
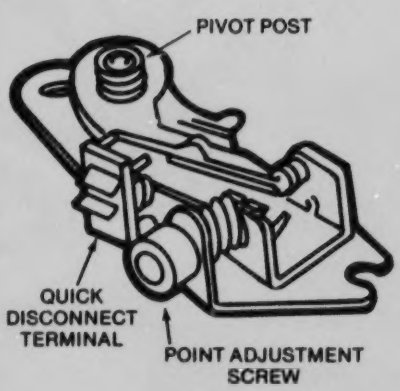


Figure 8-9 Single contact point assembly

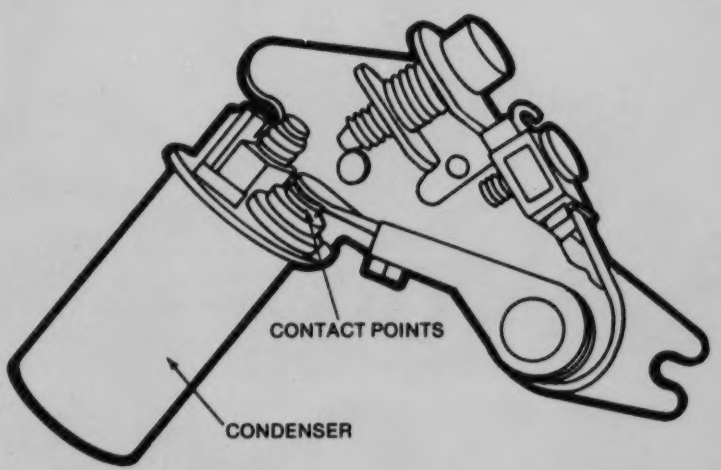


Types of Contact Points

Single contact point assembly. Most contact points are now made in a single contact point assembly. The one-unit contact set has its own pivot post for the movable point. Also, some of the single assemblies have a quick-disconnect arrangement for the wire leads, as shown in Figure 8-9. The contact points can be adjusted by turning a point adjustment screw from outside the distributor. The screw is turned through a ***window*** in the distributor cap.

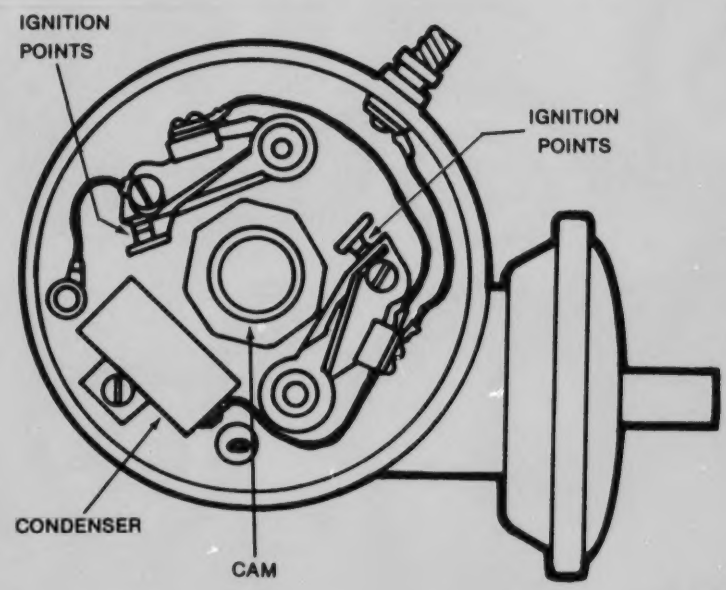
Uni-set contact point assembly. Another kind of single contact point set is the ***uni-set.*** On this assembly, the condenser is attached to the contact points, as shown in Figure 8-10. This means that the condenser will automatically be replaced when the contact points are replaced.

Figure 8-10 Uni-set contact point assembly



Dual points. On some vehicles, there are two sets of contact points. They are called dual points (see Figure 8-11). Each set operates the same as the other types described above.

Figure 8-11 Dual points assembly



VISUALLY INSPECTING THE CONTACT POINTS

The appearance and the condition of contact points can let you know the causes of problems with them. Knowing the cause will help you make the right corrections. For example, the color of normal contact points is white or gray. The color of burned contact points is blue or black. As you visually check the contact points, keep in mind the following information, which explains the action that takes place in the primary circuit as the points open and close.

When the distributor contact points close, current flows in the primary circuit. The coil builds and multiplies this voltage.

When the points opens, the primary circuit opens. The built-up voltage in the coil is sent out through its high-tension lead to the distributor cap and the spark plugs.

However, at the moment the points open, some voltage remains in the primary circuit and tends to keep the current flowing. If unchecked, this current can create an intense arc across the contact points. Arcing causes the points to burn and become pitted.

Figure 8-12 Burned or pitted points

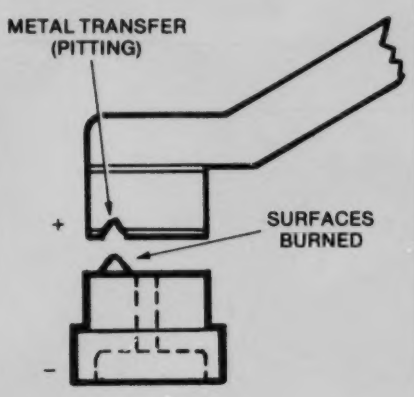


Figure 8-13 Points with excessive metal transfer

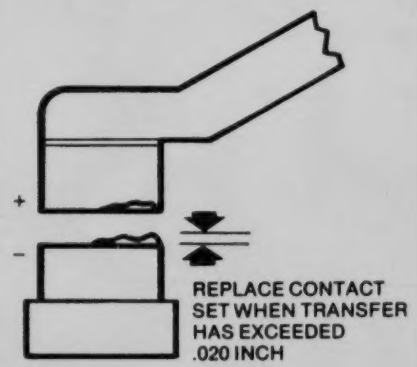
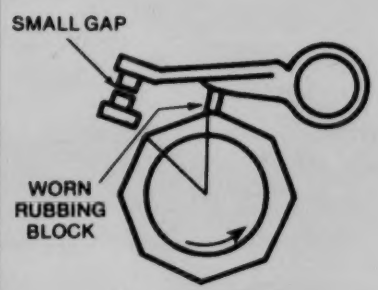


Figure 8-14 Points with too small a gap



The condenser brings the flow of current in the primary circuit to a quick stop. This keeps arcing from occurring. When the points open, the continuing primary current flows into the condenser.

Burned or Pitted Points

Burned points are caused by too much arcing, a high charging rate (high voltage), incorrect contact point adjustment, or oil or grease on the contact points.

Pitted points mean that metal has been transferred from one contact point to another, as shown in Figure 8-12. This causes a tip to form on one contact point (as on the stationary point shown in Figure 8-13). On the other (movable) point, a pit is formed.

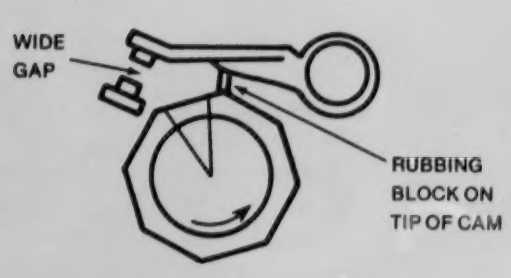
Pitted points are caused by an incorrect condenser or a poor condenser. Recently, vehicle manufacturers have stated that some pitting (transfer of the metal) is normal. Contact points should be replaced when the metal transfer exceeds .020 inch (twenty-thousandths of an inch).

Improperly Adjusted Points

Points with too small a gap remain closed too long. As a result, the spark from the coil is delivered ***late*** to the spark plugs. A small gap may also be caused by a worn-down rubbing block (see Figure 8-14). A small gap leads to arcing and burning of the points.

Too wide a gap in the contact points causes the points to open too early (see Figure 8-15). As a result, the spark from the coil is delivered ***early*** to the spark plugs. This causes the engine to miss or skip at higher speeds, since the coil does not have time to build enough electrical voltage. (The amount of time the points remain closed determines how much voltage is built up in the coil.)

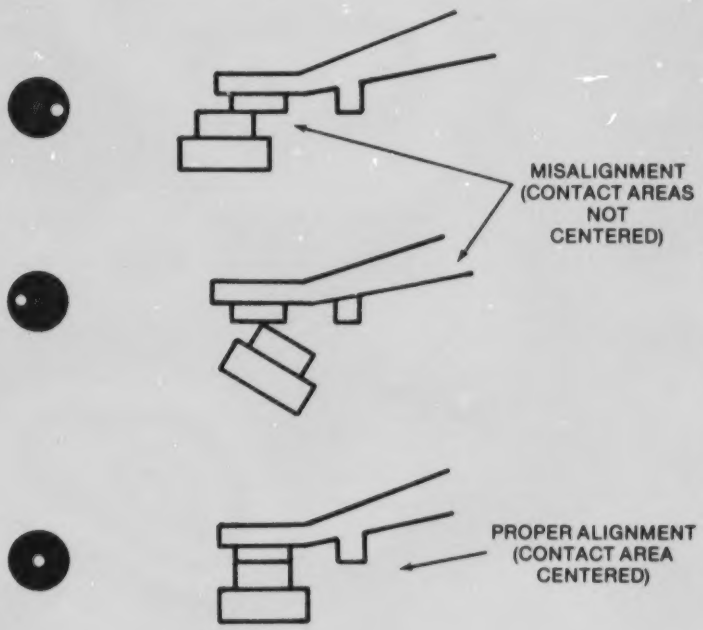
Figure 8-15 Points with too wide a gap



Improperly Aligned Points

To make a good electrical connection, contact points must meet squarely, as shown in Figure 8-16. Proper alignment will also extend the life of the points and reduce wear and heat.

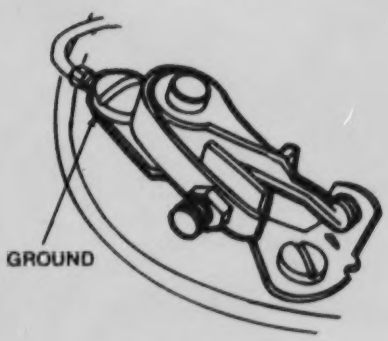
Figure 8-16 Contact point alignments



Poorly Grounded Stationary Points

The stationary point base must be clean and securely fastened to the distributor breaker plate. A poorly grounded stationary point causes the primary circuit to be partly closed. The ground screws, shown in Figure 8-17, must be tight to permit proper grounding.

Figure 8-17 Ground screws for stationary contact point



Turn to your Review Exercise Book and complete Exercise 3.

WORK ACTIVITY

Do not begin this work activity until you have your instructor's approval. If you have any difficulty, review the pages listed next to the work activity. If you still have difficulty, ask your instructor for help.

2. Visually inspect the contact points and determine their condition. List any faulty conditions. (pages 15-17) *Check your work with your instructor.*

After you have finished this activity, go on to the next section.

TESTING THE CONTACT POINTS

This section will explain how to do the contact point resistance test, the contact point adjustment tests, the contact point alignment test, and the contact point spring tension test.

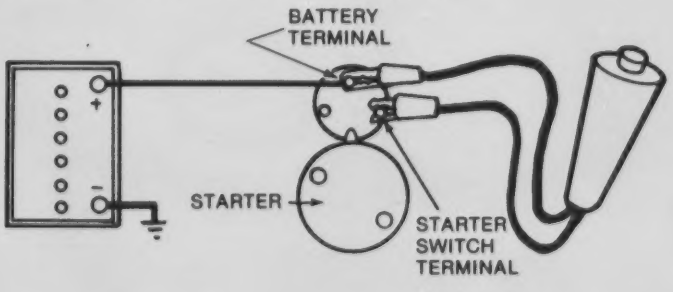
When you do these tests, use a ***remote start switch*** like the one in Figure 8-18. It allows you to crank or start an engine from the engine compartment.

Figure 8-18 Remote start switch

Remote Start Switch Hookup

All remote start switches are equipped with two insulated spring clips. These can be connected to the cranking/ignition circuit at several places, depending upon the make of the vehicle.

Figure 8-19 Remote start hookup to starter solenoid



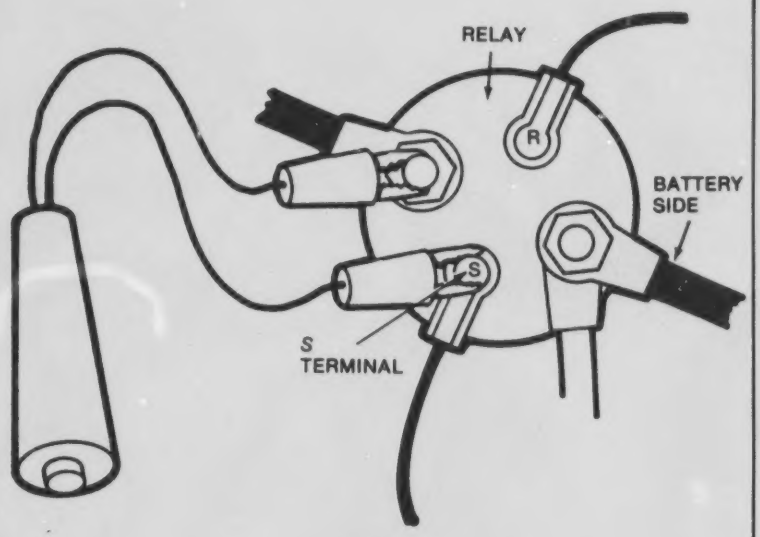
Starter solenoid hookup.

STEP 1 Connect one lead to the starter switch terminal on the solenoid.

STEP 2 Connect the other lead to the starter solenoid battery terminal (see Figure 8-19).

CAUTION: Be sure the vehicle is in *Park* or *Neutral* when cranking the engine with a remote switch.

Figure 8-20 Mounted starter relay hookup



Mounted starter relay hookup.

STEP 1 Connect one lead to the battery side of the relay, as shown in Figure 8-20.

STEP 2 Connect the other lead to the small terminal marked *S*. (If the *S* terminal wire has a quick-disconnect connector, remove the wire before connecting the leads.)

Junction block hookup.

STEP 1 Connect one lead to the battery side of the junction block, as shown in Figure 8-21.

STEP 2 Pull the quick-disconnect connector apart. Connect the other lead to the metal end of the wire leading to the solenoid.

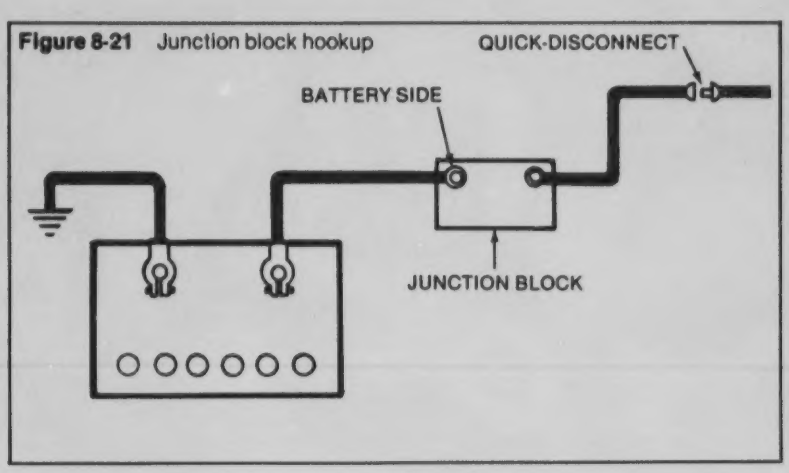


Figure 8-21 Junction block hookup

Relay box hookup. On some GM cars, a relay box is mounted on the firewall. The purple wire that runs to this box is attached to the starter solenoid.

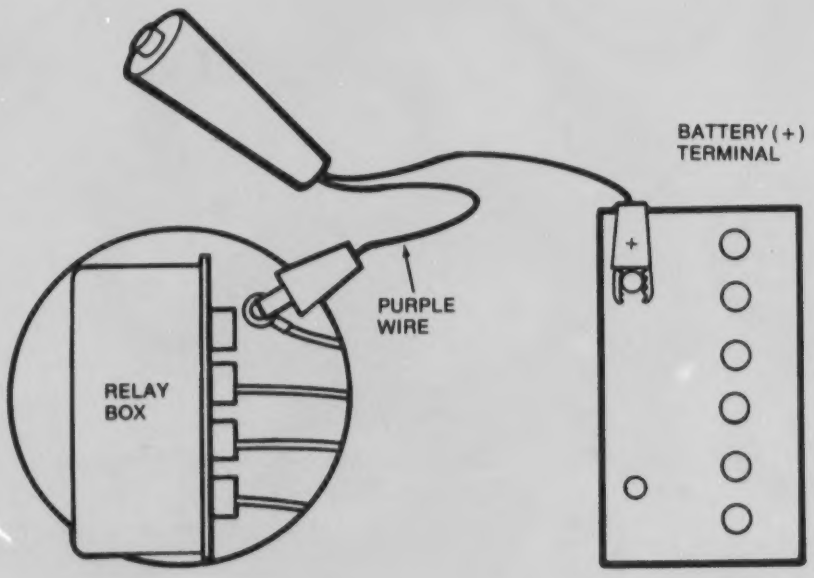


Figure 8-22 Relay box hookup

STEP 1 Disconnect the purple wire and connect one lead of the remote start switch to its end, as shown in the insert in Figure 8-22.

STEP 2 Connect the other lead to the positive (+) battery terminal post.

STEP 3 To make sure the engine does not start when cranking the engine, remove the coil wire from the center of the distributor cap.

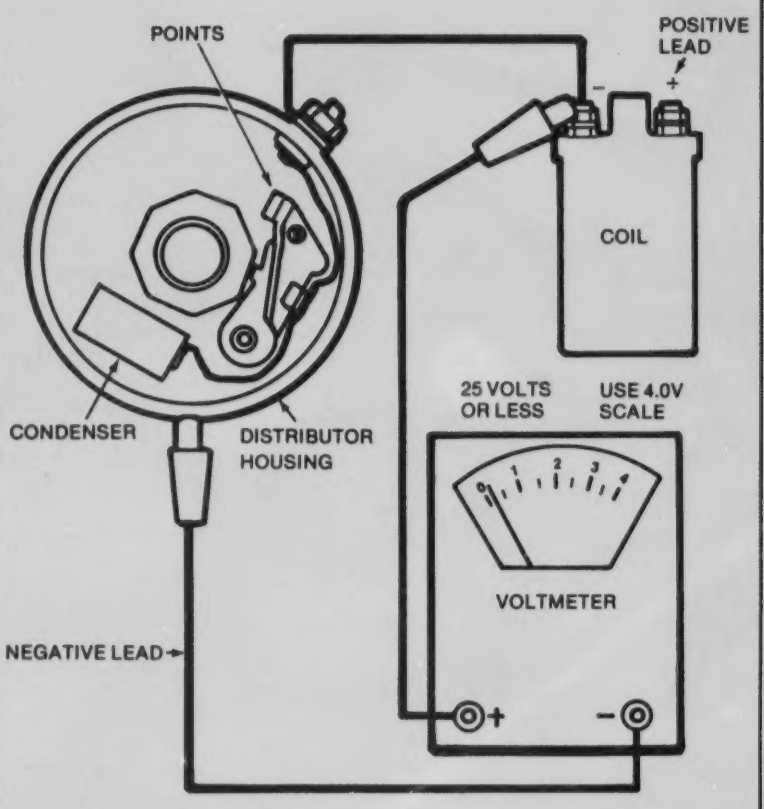
STEP 4 With a jumper wire, ground the coil wire. Connect one end of the jumper wire to the end of the coil wire. Connect the other end of the jumper wire to a good ground on the engine.

Contact Point Resistance Test

A point resistance test (made with a voltmeter) measures the amount of voltage drop through the contact points. This test is made with the points closed, the ignition switch *on*, and all lights and accessories *off*.

Excessive voltage drop (resistance) indicates improperly installed points, burned points, misaligned points, or loose lead and ground wires in the distributor.

Figure 8-23 Hookup for contact point resistance test



To make an overall test of the points and the distributor circuit (coil-to-distributor-to-ground):

STEP 1 Connect the positive test lead of the voltmeter to the primary terminal (–) on the distributor side of the coil, as shown in Figure 8-23.

STEP 2 Connect the ground (black) voltmeter test lead to the distributor housing.

STEP 3 If you are using a remote start switch, disconnect the coil wire from the center of the distributor. Connect a jumper lead to the wire and ground so that the engine won't start.

STEP 4 Crank the engine until the contact points are closed.

STEP 5 With the voltmeter set on the small scale (4.0V scale), turn the ignition switch on. Note the voltage readings. A reading of .25 volt or less means the circuit is okay. This reading also means that the voltage drop across the contact points is within allowable limits.

If the previous reading is more than .25 volt and you want to check the voltage drop across the contact points themselves:

STEP 1 Connect the positive (+) test lead of the voltmeter to the movable breaker point.

STEP 2 Connect the negative (–) test lead of the voltmeter to the distributor breaker plate (–).

If the reading is .25 volt or less, the point resistance is okay.

If the reading is more than .25 volt, check for a loose stationary base plate and a loose electrical connection at the contact point terminal. If these check okay, the points should be replaced.

Figure 8-24 Checking point resistance on dual points

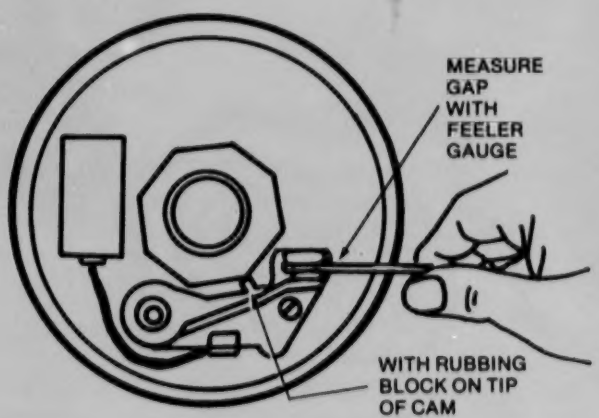
When checking point resistance or voltage drop on a dual set of contact points, block one set open with a piece of clean cardboard while the other set is being tested, as shown in Figure 8-24.

Contact Point Adjustment Tests (Point Gap)

There are two ways to test contact point gap: with mechanical feeler gauges (see Figure 8-25) and with an electrical dwell meter. Procedures for using the dwell meter will be covered in another performance objective.

Feeler gauges are used to measure the amount of opening (gap) between the two points. They are thin, leaf-like strips of metal. Each has a different thickness. The ***thickness*** of the feeler strip is the measuring guide. Each is marked in ***thousandths*** of an inch (for example, .005 inch, .006 inch, .007 inch).

Figure 8-25 Measuring point gap with feeler gauges



To measure point gap with a feeler gauge:

STEP 1 Refer to the vehicle manufacturer's specifications for the correct gap amounts. Make sure the specifications are for the distributor being checked.

STEP 2 Select the feeler gauge size that is specified by the vehicle manufacturer.

STEP 3 Wipe away any excess dirt on the distributor cap or in the surrounding area. Then, remove the distributor cap and the rotor.

STEP 4 Crank the engine to turn the distributor cam until the rubbing block is on one of the cam's tips (see Figure 8-26). Then, turn off the ignition switch.

STEP 5 Slide the feeler gauge through the contact point opening. The feeler gauge should just touch both contacts. (Be sure the gauge is clean and free of grease. If grease is on the points, the engine may not start.)

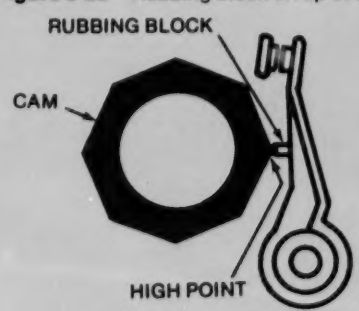
If the feeler gauge slides through without any contact with the points, the points are too far apart.

If the feeler gauge drags heavily and moves the movable point away, the points are too close.

Remember: If pitting and metal transfer has taken place on used points, accurate results will not be obtained with a feeler gauge. This is because the feeler gauge will measure the gap from the tip of the metal transfer instead of from the main surface area of the contact point.

As a result, on used points, you must measure point gap with a dwell meter.

Figure 8-26 Rubbing block on tip of cam



Contact Point Alignment Test

To check the contact points for proper alignment:

STEP 1 Crank the engine until the points are closed.

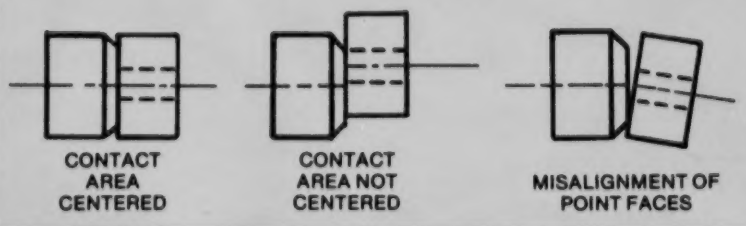
STEP 2 Turn the ignition switch off.

STEP 3 Work the movable point in and out slowly. Observe its alignment with the stationary contact point.

The surfaces of both contact points must connect squarely with each other for a good electrical connection, as shown in the first diagram in Figure 8-27. If they don't, an adjustment is required. (This adjustment will be covered in another performance objective.)

Single contact point sets, as well as uni-sets, are pre-aligned at the factory. If point alignment is incorrect on these sets, the entire set should be replaced.

Figure 8-27 Contact points centered, not centered, and misaligned



Contact Point Spring Tension Test

Spring tension is important. Too little tension will allow the contact points to float, causing too much arcing, and skipping or missing of the engine. Too much tension will allow the contact points to bounce at higher speeds, causing severe arcing that will burn the points. Too much tension will also cause wear to the rubbing block, cam, and distributor shaft bushings.

To test the contact points for proper spring tension:

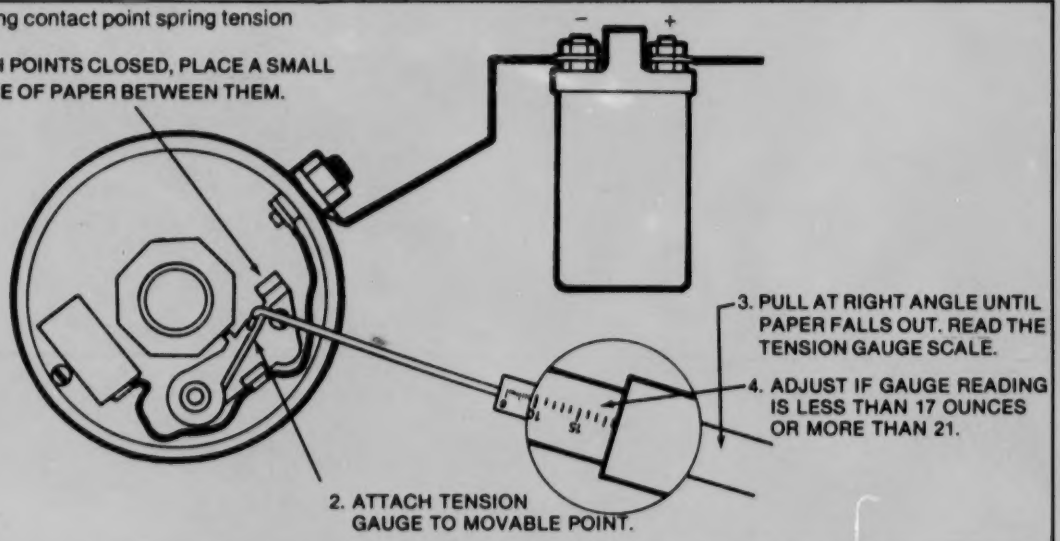
STEP 1 With the points closed, place a small piece of paper between them, as shown in Figure 8-28.

STEP 2 Hook the spring tension gauge onto the movable contact point arm, as close to the contact point as possible (see Figure 8-27).

STEP 3 Gently pull the tension gauge at a right angle from the contact point until the paper falls out.

STEP 4 Note the reading on the gauge. (Readings are in ***ounces*** of pressure.)

Figure 8-28 Testing contact point spring tension


1. WITH POINTS CLOSED, PLACE A SMALL PIECE OF PAPER BETWEEN THEM.
2. ATTACH TENSION GAUGE TO MOVABLE POINT.
3. PULL AT RIGHT ANGLE UNTIL PAPER FALLS OUT. READ THE TENSION GAUGE SCALE.
4. ADJUST IF GAUGE READING IS LESS THAN 17 OUNCES OR MORE THAN 21.
- +

The reading is *good* if it is between 17 ounces and 21 ounces.

The reading is ***bad*** if it is below 17 ounces or above 21 ounces. Spring tension must be adjusted, or the points must be replaced.

The spring tension on single contact point sets as well as on uni-sets is preset at the factory. If spring tension is incorrect on these sets, they should be replaced.

Turn to your Review Exercise Book and complete Exercise 4.

WORK ACTIVITY

Do not begin this work activity until you have your instructor's approval. If you have any difficulty, review the pages listed next to the work activity. If you still have difficulty, ask your instructor for help.

3. Test the points for resistance, adjustment, alignment, and spring tension. Record your results and compare them with the vehicle manufacturer's specifications. (pages 18-25) *Check your work with your instructor.*

After you have finished this activity, go on to the next section.

LOCATION AND OPERATION OF THE CONDENSER

Condenser Location

The condenser body is mounted to a base plate or a clamp, or is

placed in a spring clamp. Then, the clamp is attached to the distributor breaker plate assembly.

The condenser lead is attached to the terminal on the contact point set, as shown in Figure 8-29. At the terminal the condenser lead also makes connection with the primary wire from the coil. Electrically, then, the condenser is placed across the points.

Some condensers, such as those on uni-set contact points, are directly attached to the single, one-piece set. The condenser is replaced at the same time the points are replaced.

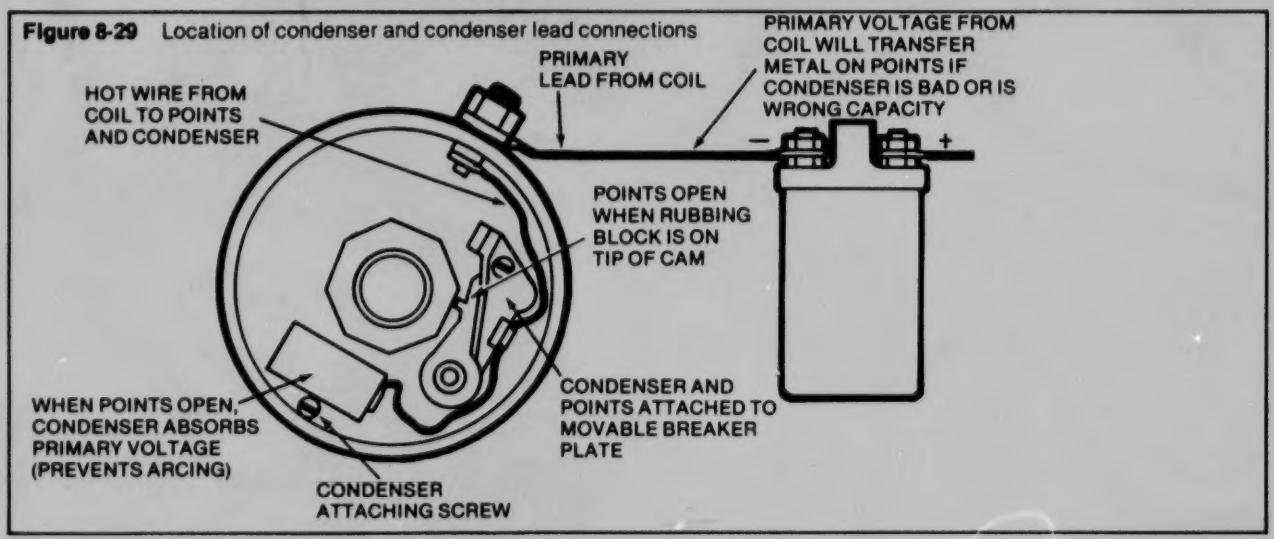

PRIMARY VOLTAGE FROM COIL WILL TRANSFER METAL ON POINTS IF CONDENSER IS BAD OR IS WRONG CAPACITY
PRIMARY LEAD FROM COIL
HOT WIRE FROM COIL TO POINTS AND CONDENSER
POINTS OPEN WHEN RUBBING BLOCK IS ON TIP OF CAM
CONDENSER AND POINTS ATTACHED TO MOVABLE BREAKER PLATE
WHEN POINTS OPEN, CONDENSER ABSORBS PRIMARY VOLTAGE (PREVENTS ARCING)
CONDENSER ATTACHING SCREW
–
+

Figure 8-29 Location of condenser and condenser lead connections

Condenser Functions

The condenser has two basic functions in the ignition system:

(1) It must absorb the ***continuing*** electric charge of current at the moment the contact points open. Otherwise, arcing will take place causing the points to burn.

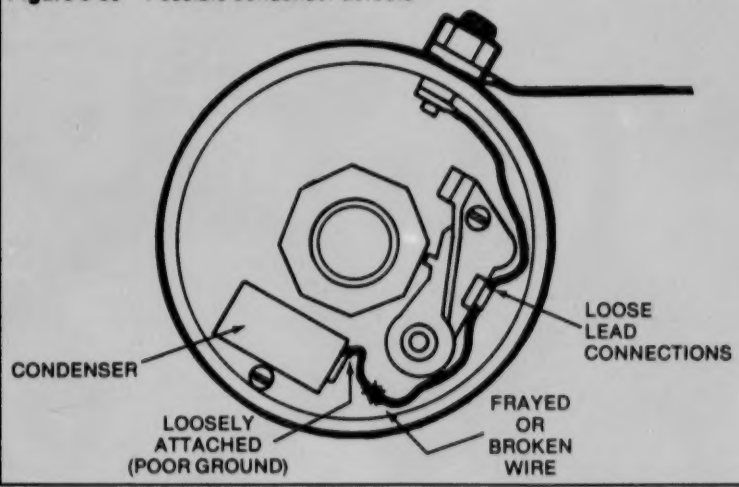
(2) It must be able to hold the electric charge. To do this, it must have the proper capacity for the ignition system in which it is installed. Not enough capacity or too much capacity will cause metal to transfer on the contact points. This will cause pitting of the points.

CONDENSER DEFECTS

Lead Wire That Is Broken or Frayed

Any damage to the condenser lead wire can cause complete malfunction of the condenser (see Figure 8-30). A frayed wire in ***direct*** contact with metal will short out the circuit to the condenser. The engine will not operate if the condenser lead is broken or if there is a direct short in the electrical circuit.

Figure 8-30 Possible condenser defects

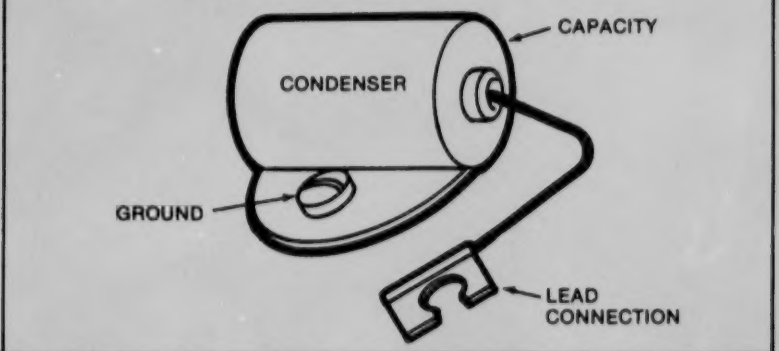


Loose Condenser Connection

Condensers that are loose provide a poor ground (see Figure 8-30). This results in poor condenser absorption of electric current when the points open. Poor grounding also means that the condenser will not be able to hold an electric charge during the ignition cycle.

Condenser connections may become loose at two points: at ground and at the terminal (see Figure 8-31). If either of these connections is loose, the contact points will arc or burn. Also, the engine will miss, skip, or be hard to start.

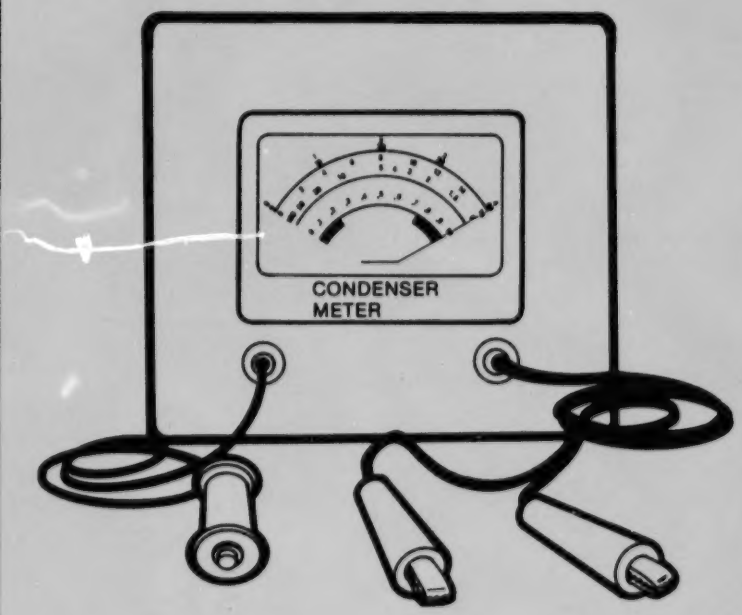
Figure 8-31 Areas where condenser may malfunction



CONDENSER TEST PROCEDURES

The condenser tester (see Figure 8-32) is used to test three conditions of the condenser: series resistance, leakage, and capacity. The results of these tests will let you know whether the condenser is operating correctly.

Figure 8-32 Condenser tester



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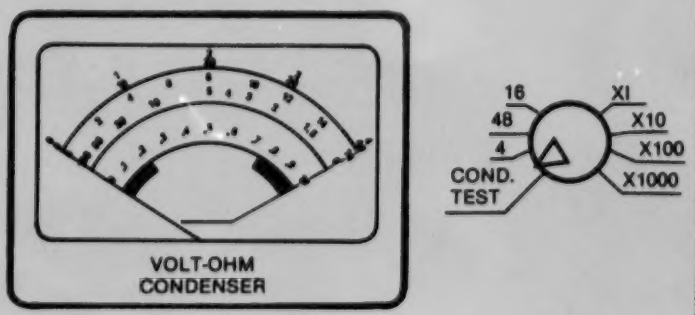
To calibrate the tester: Connect the condenser test leads together and turn the ***condenser calibration*** (COND. CAL.) knob to the right until the indicator is on the SET LINE, as shown in Figure 8-33.

Figure 8-33 Calibrating the tester



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To hook up the condenser:

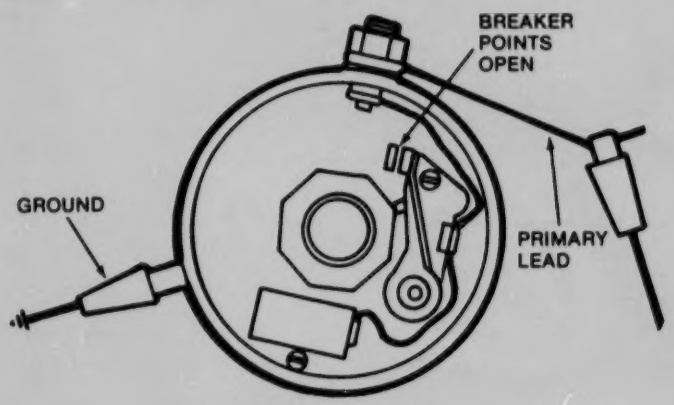
STEP 1 Disconnect the distributor primary lead (–) at the coil.

STEP 2 Connect one condenser tester lead to the distributor primary lead.

STEP 3 Connect the other tester lead to the distributor housing (ground).

STEP 4 Rotate distributor cam until points are open, as shown in Figure 8-34.

Figure 8-34 Tester hookup with breaker points open



Condenser Series Resistance Test

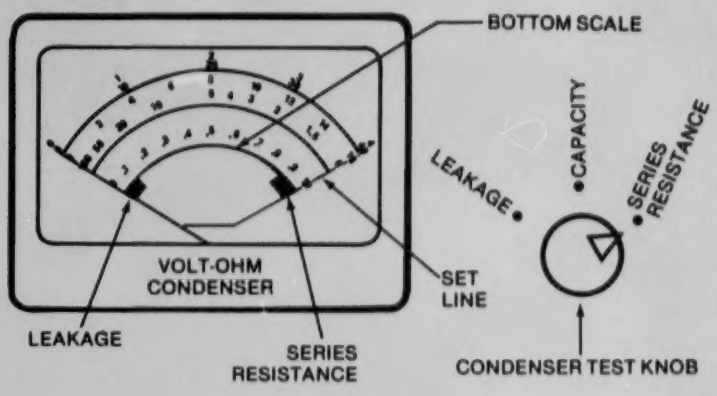
This test shows whether the amount of resistance in the condenser lead and in the ground circuit is normal or high. (High resistance is caused by broken wires, bad lead connections, and poor internal condenser contacts.)

The ***condenser test knob*** is spring-loaded in the ***series resistance*** position (on the right end of the scale). This means the needle should remain in the ***black band*** at the right end of the scale (see Figure 8-35).

STEP 1 Move the condenser and primary coil leads back and forth. If the needle moves ***out*** of the black band on the right or moves ***into*** the black band on the left, the leads or ground circuit have excessive resistance. This means the wires are broken or have poor connections.

STEP 2 To eliminate the primary coil lead as the cause, move the tester lead to the end of the condenser lead and repeat the test.

Figure 8-35 Bottom scale of condenser tester for resistance test



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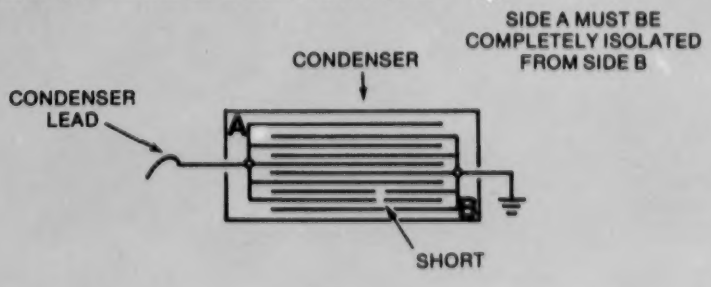
STEP 3 To check for excessive resistance in the ground circuit, remove the ground tester lead and connect it to the body of the condenser. If the meter reads in the black band on the left, check for a poorly grounded condenser or distributor body.

If the condenser fails any of these tests, replace the condenser.

Condenser Leakage Test

This test shows the amount of current that is leaking from one side of the condenser to the other. It also shows whether there is an insulation defect that could cause a breakdown or leak. A breakdown or leak in the insulation allows the electric spark to escape to ground. This condition is referred to as a ***shorted*** condenser, as shown in Figure 8-36.

Figure 8-36 Internal condenser, Sides A and B



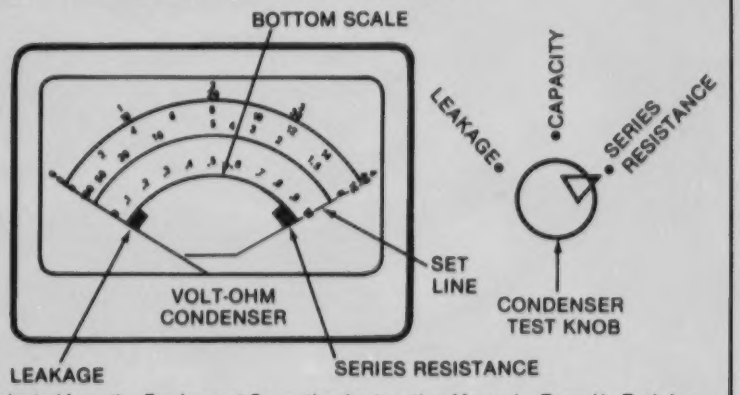
To perform the condenser leakage test:

STEP 1 Move the ***condenser test knob*** to ***leakage***.

STEP 2 Read the test results. There is no leakage if the indicator is in the black band at the left end of the scale (see Figure 8-37).

CAUTION: ***Do not touch*** the test leads or condenser lead while making this test. You can receive a severe shock.

Figure 8-37 Condenser tester setting for leakage test



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Condenser Capacity Test

This test shows whether the condenser is the right size—that is, whether it has the proper capacity for the vehicle. The condenser must be large enough to absorb the ***continuing*** electric current and prevent arcing and burning of the contact points. Also, it must be small enough to reduce the transfer of metal from one contact point to another.

To make a condenser capacity test:

STEP 1 Move the ***condenser test knob*** to ***capacity***.

STEP 2 Read the test results.

The condenser is ***good*** if the indicator falls within the allowable capacity range. The condenser is ***bad*** if it does not meet specifications.

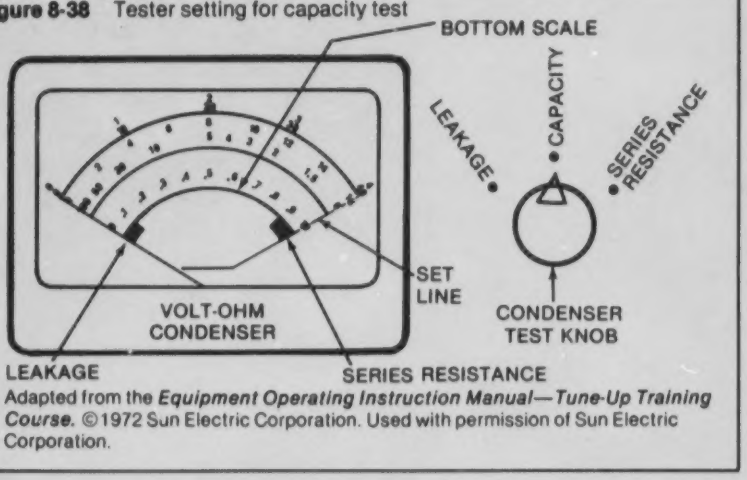

Figure 8-38 Tester setting for capacity test

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POINTS AND CONDENSER: SUMMARY OF DEFECTS AND CORRECTIONS

The following troubleshooting table lists various engine troubles that can be caused by defects in the contact points, condenser, and coil-to-distributor primary circuit. The table also shows steps that may be taken to correct such conditions.

Table 8-1 Points and Condenser: Defects and Corrections

Condition	Possible Cause	Check or Correction
Engine runs but misses	Points dirty, worn, or out of adjustment	Clean, replace, or adjust the points
	Bad connections	Clean and tighten the connections
	Defective condenser	Replace the condenser
Engine cranks normally but will not start	Points not opening	Adjust the points
	Burned points	Replace the points
	Defective condenser	Replace the condenser
	Open primary circuit	Check for open connections
	Grease on the points	Clean the points
Pitted contact points	Transfer of metal	For buildup on negative point, replace the condenser with one having lower capacity For buildup on positive point, replace the condenser with one having higher capacity
Burned contact points	High charging rate	Check the charging rate
	Incorrect point gap	Adjust the point gap
	Weak contact point spring tension	Adjust the spring tension
	Oil, grease, or crankcase vapors entering the distributor	Clean the points and correct the gap
	Too much resistance in condenser circuit	Tighten the condenser mounting and connection Check the primary wire Replace the condenser if in bad condition

Turn to your Review Exercise Book and complete Exercise 5.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

4. Inspect the condenser. List any defects you find. (pages 25-27)

5. Test the condenser. Record your results and compare them with the vehicle manufacturer's specifications. (pages 27-33)
Check your work with your instructor.

When you have finished these activities, ask your instructor to return your pretest on Performance Objective 8. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will then tell you if you are ready to be checked off on the performance checklist or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

PERFORMANCE OBJECTIVE 9

REMOVE AND REPLACE IGNITION POINTS AND CONDENSER

INTRODUCTION TO P.O. 9

In this performance objective, you'll learn how to remove and replace the contact points and condenser.

You may find it helpful to review Performance Objective 8, where you'll find information on testing the points for resistance, adjustment, and spring tension.

After you have finished all the activities for Performance Objective 9, your instructor will use a checklist like the one below to evaluate your work.

Performance Checklist—P.O. 9

The instructor will provide either a live vehicle or a live engine. Replace the points and condenser. All of the performances below must be accomplished.

Student Performances	Instructor Ratings		
	Acceptable	Not Acceptable	Omit
1. Removes distributor cap and rotor.			
2. Removes points and condenser.			
3. Cleans breaker plate and lubricates cam.			
4. Installs points and condenser.			
5. Aligns contact points.			
6. Adjusts contact points spring tension.			
7. Sets initial point gap, using feeler gauge.			
8. Sets final point gap, using dwell meter.			
9. Replaces cap and rotor.			
10. Adjusts engine idle.			
11. Adjusts ignition timing.			
12. Uses the proper tools and equipment.			
13. Follows all appropriate safety precautions.			
14. Performs tasks in an acceptable amount of time.			

SAMPLE

Tools and Equipment

For this objective, you will need to use the tools and equipment listed below. You will be given the procedures for using special tools and equipment as you work through the activities.

Basic Hand Tool Set

Special Hand Tools

point aligning tool
distributor wrenches
tune-up wrench set
feeler gauge set

Basic Equipment

timing light
dwell meter
tachometer
fender covers
extension light

Reading List

If you would like additional information as you work through this performance objective, use the references below.

General References

Crouse, *Automotive Mechanics,* pp. 315, 319-20.

Crouse, *The Auto Book,* pp. 364-65.

Ellinger, *Automechanics,* p. 294.

Stockel, *Auto Mechanics Fundamentals,* pp. 62-63.

Stockel, *Auto Service and Repair,* pp. (21-12)-(21-21).

Toboldt and Johnson, *Automotive Encyclopedia,* pp. 402-7.

Special-Purpose Reference

Crouse, *Automotive Electrical Equipment,* Ch. 14.

Personal and Service Safety Practices

Safety When Working around an Operating Engine

Personal Safety. Do not reach into an engine without looking first, since your fingers can get caught in moving parts.

When setting ignition timing, always place the timing light leads and the droplight cord away from the engine fan. Also, always keep your hands and the timing light a safe distance from the fan blades when setting the timing. If you are not careful, you can be badly injured.

Fender covers. Always use fender covers when working under the hood. This prevents scratching the fenders with tools and equipment.

Safety in Work Clothing and Grooming

Hair. Keep hair away from moving parts. If your hair hangs below your collar, wear a hat.

Jewlery. Avoid wearing any metal (rings, buckles, wristwatches, necklaces) that can get caught in parts or can come in contact with electrical parts.

Clothing. Avoid wearing loose clothing, since it can get caught in equipment and cause serious injury.

Safety When Making an Electrical Test

Procedures. Always follow the test equipment manufacturer's procedures for properly using the equipment and for making important equipment calibrations.

Personal safety. Never do any electrical tests when standing on a wet floor or when vehicle or engine parts are wet.

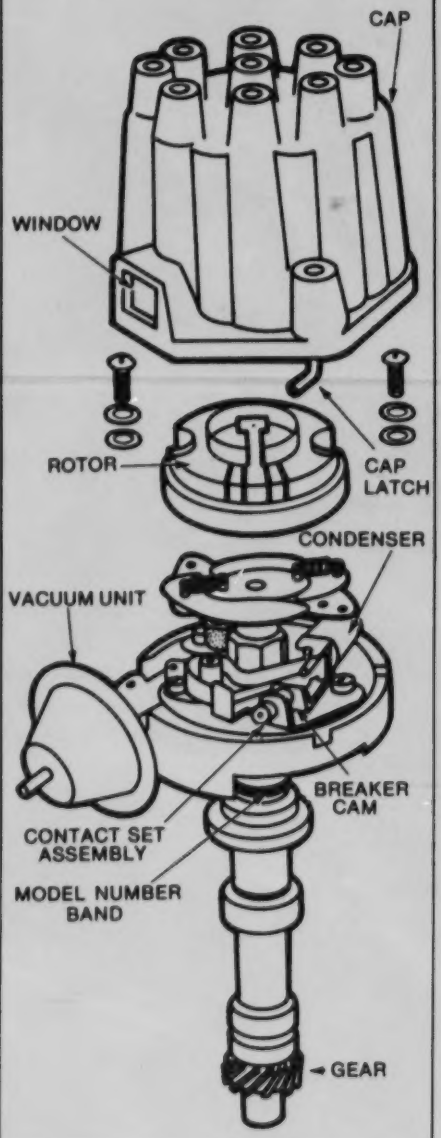
Never connect the timing light lead to the spark plug while the engine is running. You can receive a severe shock.

Safety When Working around the Vehicle Distributor

Cleanliness. Always wipe the distributor cap and surrounding area clean before removing the cap. This keeps dirt from getting inside the distributor.

Correct tools. Always use the correct tools and equipment when removing, replacing, and adjusting the contact points. This will help you avoid damaging the points.

Figure 9-1 Parts in a typical distributor



REMOVING AND REPLACING THE CONTACT POINTS AND CONDENSER

It is recommended that you remove the distributor from the engine when replacing the contact points and condenser. The distributor can then be placed on a testing machine where you can check and adjust it, and perform any further services. (In emergencies, you can install a set of points and a condenser without removing the distributor.) The following procedures for removing and installing the contact points and condenser are done with the distributor in the engine.

Before you begin these procedures, gather the proper tools and equipment and bring them to the work area. This will save you time on the job. Arrange the extension light so that the work area is well lighted. Remove the carburetor air cleaner if it is in the way. Also, make sure you wipe away any dirt around the distributor cap.

Removing the Contact Points and Condenser

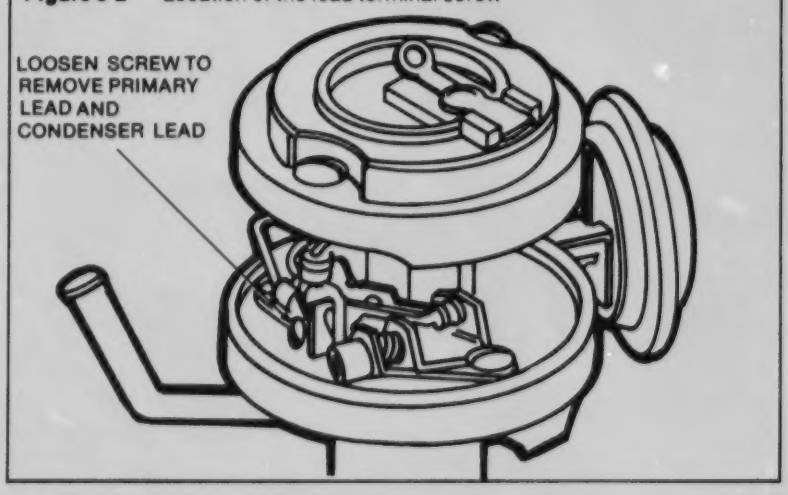
STEP 1 Remove the distributor cap as described in Performance Objective 8. Remove the rotor if necessary (see Figure 9-1).

STEP 2 If the distributor has a radio frequency insulator (R.F.I.) shield, remove this shield.

STEP 3 Stuff cloth into any openings in the breaker plate assembly. This will keep you from dropping screws, washers, or other parts into the distributor housing.

STEP 4 For single contact point sets, loosen the lead terminal screw, as shown in Figure 9-2. Then remove the primary lead and the condenser lead.

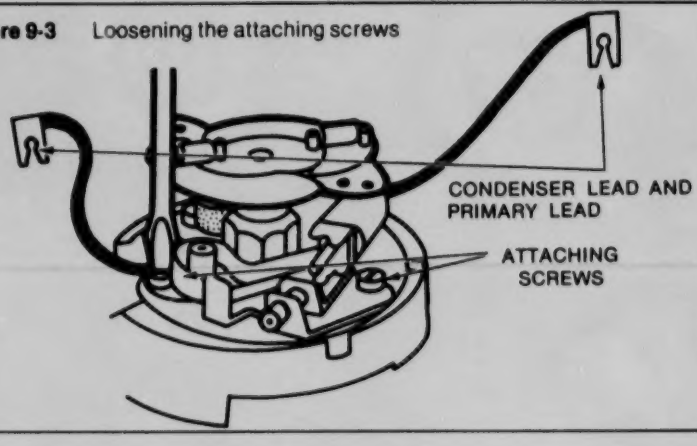
Figure 9-2 Location of the lead terminal screw



NOTE: On some contact points, there is a nylon-insulated, quick-disconnect terminal. Simply press in against the terminal clamp and remove the leads.

STEP 5 Loosen the two attaching screws that secure the base of the contact points to the breaker plate, as shown in Figure 9-3.

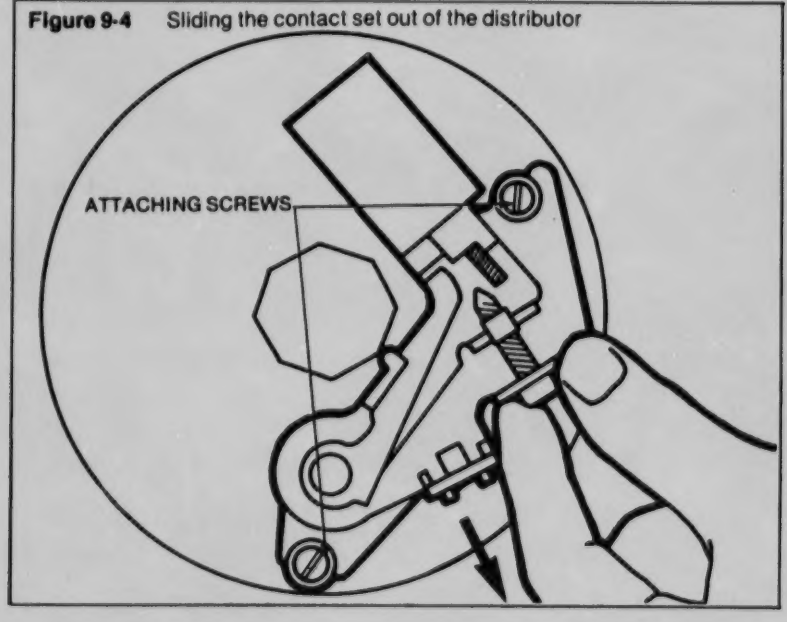
Figure 9-3 Loosening the attaching screws



STEP 6 Then, slide the contact set out from under the screws, as shown in Figure 9-4.

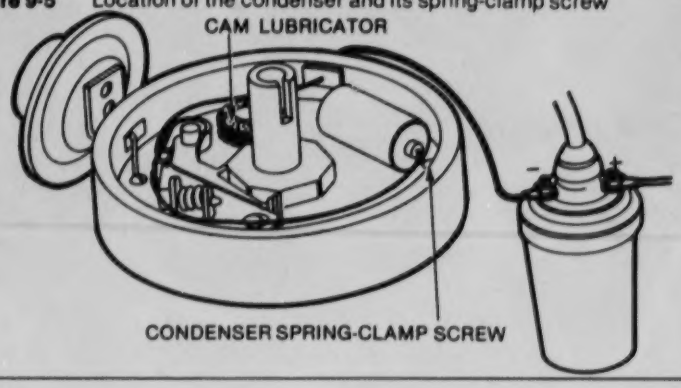
NOTE: On some contact points, there is only one attaching screw. On others, the screw must be removed ***before*** lifting the assembly out of the distributor.

Figure 9-4 Sliding the contact set out of the distributor



STEP 7 Remove the condenser by removing its spring-clamp screw (see Figure 9-5). Then, lift the condenser up and away from the breaker plate. If a lock-type screwdriver is not available, leave the attaching screw in the clamp and lift out the condenser and the attaching screw together. This will keep you from dropping the attaching screw.

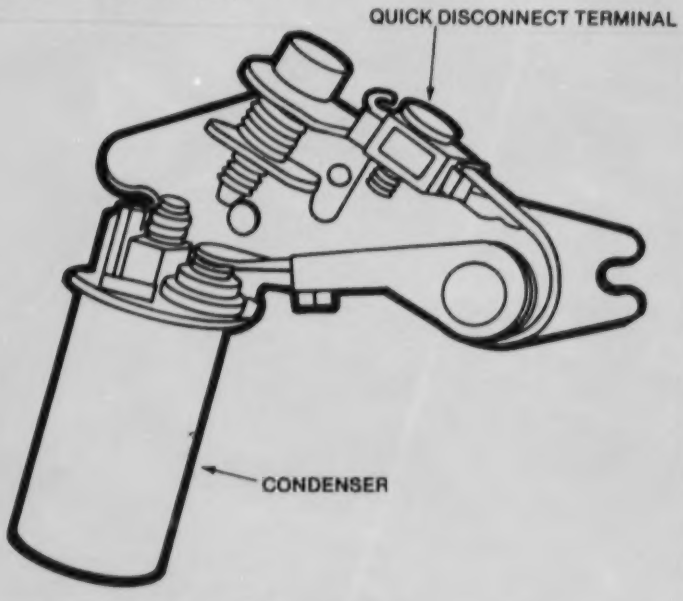
Figure 9-5 Location of the condenser and its spring-clamp screw



Some single contact point sets have attached condensers, called ***uni-sets.*** To remove a uni-set, do the following:

STEP 1 Remove the primary lead from the nylon-insulated, quick-disconnect terminal (see Figure 9-6).

Figure 9-6 Uni-set contact points



STEP 2 Loosen the uni-set attaching screws and slide the uni-set out of the distributor.

To remove conventional two-piece contact points, do the following:

STEP 1 Loosen the terminal post nut and remove the condenser lead, as shown in Figure 9-7.

Figure 9-7 Loosening terminal post nut

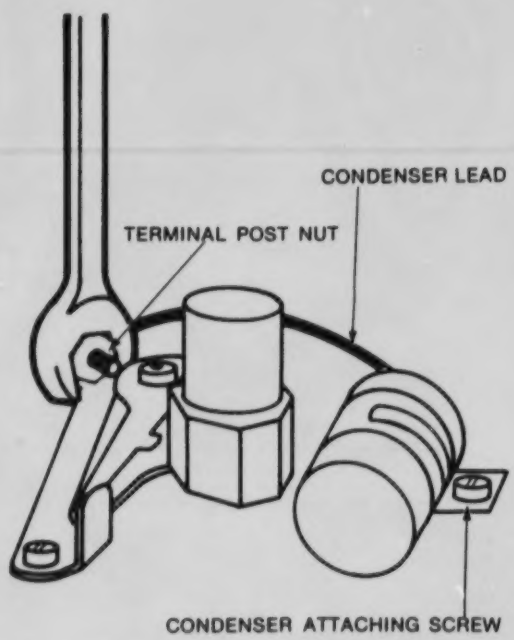
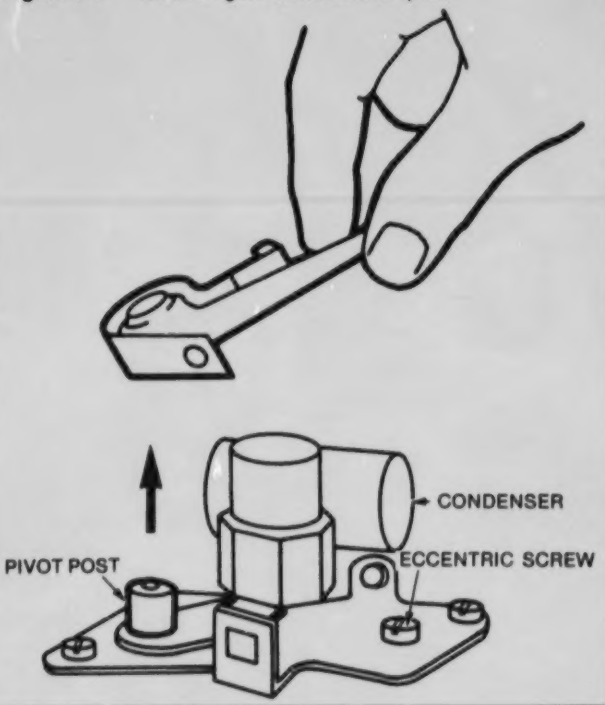


Figure 9-8 Removing movable contact point



STEP 2 Slide the movable contact point from the terminal post and from the pivot post on the breaker plate, as shown in Figure 9-8.

STEP 3 Remove the attaching screw from the stationary contact point base. Lift the contact point ***away*** from the eccentric screw and the pivot post.

STEP 4 Remove the condenser attaching screw, and lift the condenser from the distributor breaker plate.

Installing the Contact Points and Condenser

Before installing a new set of contact points and condenser, make sure the distributor cam and the distributor breaker plate assembly are clean. The breaker plate assembly must be clean in order to be a good ground for the stationary contact point and the condenser.

Figure 9-9 Location of cam lubricator

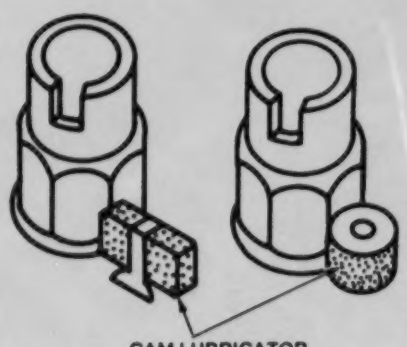


Figure 9-10 Tightening contact attaching screws

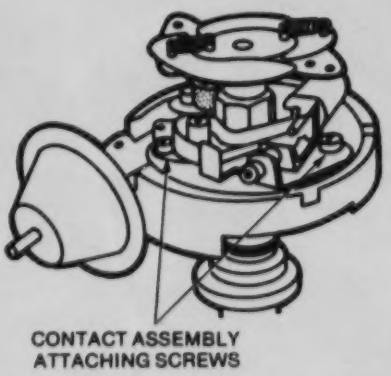
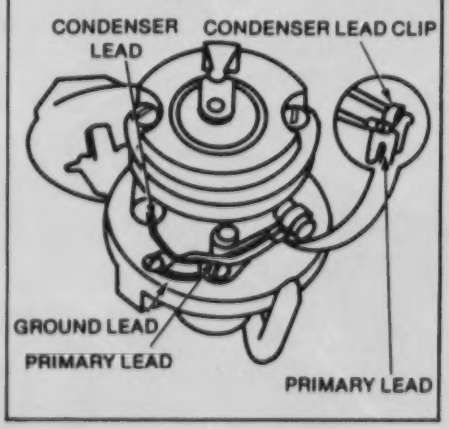


Figure 9-11 Primary lead and condenser with quick-disconnect terminals



Apply a thin coating of cam lubricant around the distributor cam, or install a new cam lubricator. When applying a coat of lubricant, use ***only*** distributor cam lubricant. It is a highly heat-resistant lubricant made especially for distributor cams. This lubricant keeps the rubbing block from wearing out.

CAUTION: Apply only a ***thin*** coating of lubricant. Too much lubricant will spatter on the contact points and will cause the points to burn. Also, too much lubricant will cause dirt to collect on the breaker plate assembly.

If you install a new cam lubricator, it should be positioned so that it just touches the cam lobes, as shown in Figure 9-9. It should never be oiled.

To install single contact point sets do the following:

STEP 1 Place the new contact point set on the breaker plate and tighten the two attaching screws, as shown in Figure 9-10. (On some contact point sets, only ***one*** attaching screw is used.)

STEP 2 Install the condenser and tighten its locking screw.

STEP 3 Insert the condenser lead and the primary lead into the terminal on the contact point set. Tighten the terminal post nut. On quick-disconnect terminals, insert both leads into the terminal and push them all the way down (see Figure 9-11).

CAUTION: Double-check the primary lead and condenser lead to be sure they are not touching moving parts or a ground source. Also make sure the leads will not interfere with the normal movement of the breaker plate assembly.

NOTE: When installing a uni-set in a distributor equipped with an R.F.I. shield, the shield may be discarded. The uni-set doesn't have a condenser lead that causes radio interference. However, the R.F.I. shield must be used with other single contact point assemblies.

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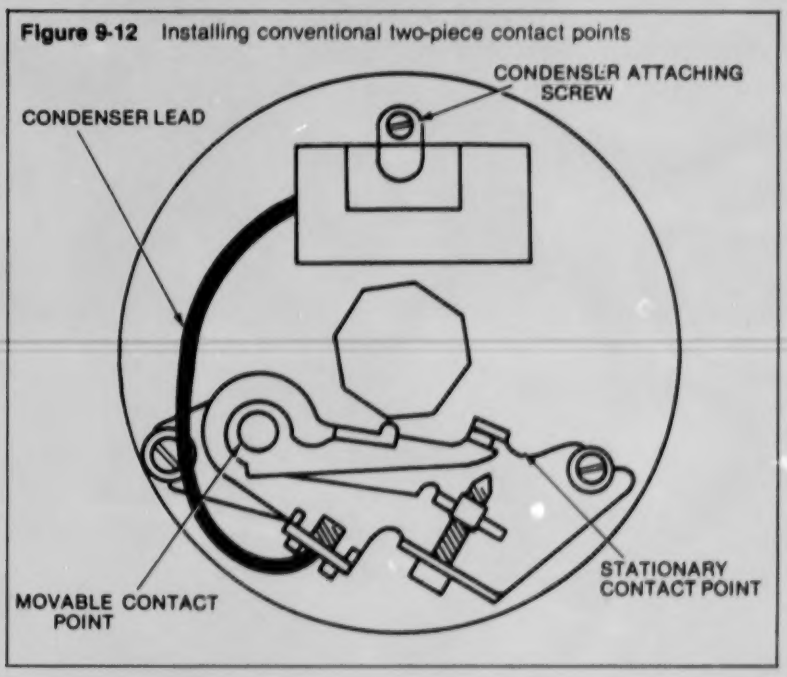
To install conventional two-piece contact points do the following:

STEP 1 Install the stationary contact point over the pivot post. Press downward to be sure the point is flush on the breaker plate surface. Install and tighten the attaching screw (see Figure 9-12).

Figure 9-12 Installing conventional two-piece contact points



STEP 2 Slide the movable contact point over the post. At the same time, slide the end of the spring arm onto the terminal lead post.

STEP 3 Install the condenser and tighten its attaching screw.

STEP 4 Slide the condenser lead onto the terminal post to make contact with the end of the spring arm of the movable contact point. Tighten the terminal connection.

CAUTION: Make sure the condenser lead has a good, tight electrical connection. It should *not* touch any moving parts.

STEP 5 Remove the protective cloths from the breaker plate openings.

Turn to your Review Exercise Book and complete Exercise 6.

WORK ACTIVITY

Do not begin this work activity until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

1. **Remove and install the contact points and the condenser. (pages 40-45)** *Check your work with your instructor.*

After you have finished this activity, go on to the next section.

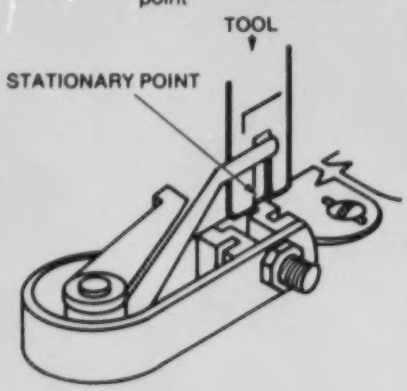


Figure 9-13 Bending stationary contact point

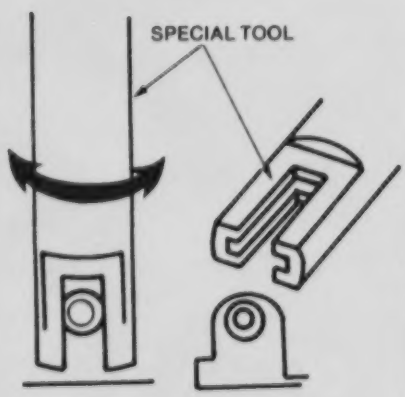


Figure 9-14 Special contact point bending tool

ALIGNING AND ADJUSTING CONTACT POINTS

Adjusting the Contact Point Alignment

The contact points must be installed on the breaker plate assembly in order to properly align and adjust them.

STEP 1 Rotate the distributor cam until the contact points are closed.

STEP 2 Visually check to see if the contact faces meet each other squarely. They must have correct lateral alignment and centered faces.

STEP 3 To make corrections, use a special contact point bending tool. Bend the stationary contact point *only* (see Figure 9-13). If you bend the movable point, you might break it.

Slip the bending tool over the contact point, as shown in Figure 9-14. Apply pressure and bend it in and out and back and forth, or twist it until the points are properly aligned. Bend it a little, check it, and bend it a little more, until the alignment is as exact as possible.

NOTE: Uni-set contact point sets and one-piece contact point sets are prealigned at the factory. If the contact point alignment is incorrect, replace the entire set.

Adjusting Contact Point Spring Tension

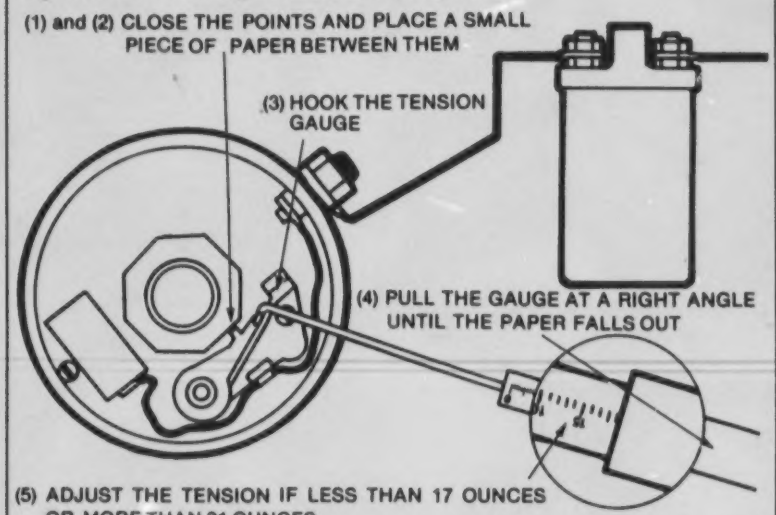
Checking contact point spring tension.

STEP 1 Rotate the distributor cam until the points are closed. (If you have just adjusted the contact point alignment, the points should already be closed.)

STEP 2 Place a small piece of paper between the contact points. Be sure the paper is clean, not greasy.

STEP 3 Hook the special spring tension gauge onto the movable contact point arm, as shown in Figure 9-15. This must be placed as close to the contact point as possible.

Figure 9-15 Checking contact point spring tension


(1) and (2) CLOSE THE POINTS AND PLACE A SMALL PIECE OF PAPER BETWEEN THEM
(3) HOOK THE TENSION GAUGE
(4) PULL THE GAUGE AT A RIGHT ANGLE UNTIL THE PAPER FALLS OUT
(5) ADJUST THE TENSION IF LESS THAN 17 OUNCES OR MORE THAN 21 OUNCES

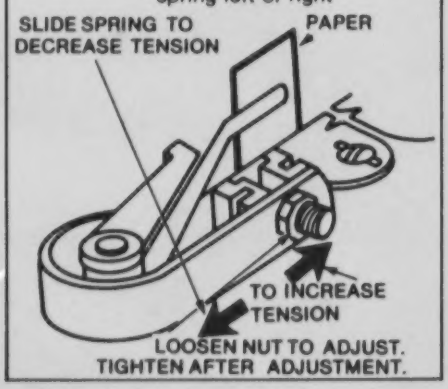
STEP 4 Gently pull the spring tension gauge straight back, in line with the contact point, until the paper falls out. If you pull the gauge at an angle, you will not obtain a true reading.

STEP 5 Note the reading on the spring tension gauge. (The tension is measured in ***ounces of pressure.***)

Refer to manufacturer's specifications for spring tension by year, make, and engine size. Generally, adjustment is required if the reading is ***less than 17 ounces*** or ***more than 21 ounces.***

NOTE: Uni-set contact point sets and one-piece contact point sets are preadjusted. If spring tension does not meet manufacturer's specifications, replace the entire set.

Figure 9-16 Adjusting contact point spring tension by sliding spring left or right



To adjust contact point spring tension, do the following:

STEP 1 Decrease the tension of the movable contact point by loosening the nut and lead connections on the terminal post. Then slide the spring arm ***toward*** the contact point pivot post, as shown in (Figure 9-16).

STEP 2 To increase the tension, slide the spring arm ***away*** from the contact point pivot post, as shown in Figure 9-16.

STEP 3 Retighten the nut and lead connections. Then, recheck the contact point spring tension.

STEP 4 Repeat the adjustments until the spring tension reading meets the vehicle manufacturer's specifications.

Adjusting Contact Point Gap

Adjust the contact point gap on new points to manufacturer's specifications, using a feeler gauge. Then, check the adjustment with a dwell meter. (Used points should be tested and adjusted *only* with a dwell meter.)

Using the feeler gauge method.

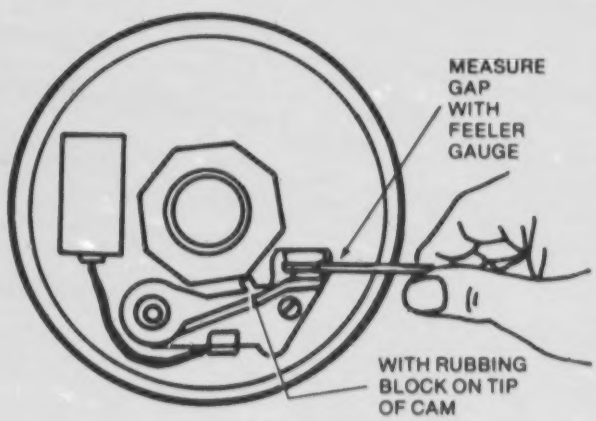
STEP 1 Look up the vehicle manufacturer's specifications to find the correct contact point gap setting.

STEP 2 Select the proper feeler gauge size, as specified by the vehicle manufacturer.

STEP 3 Turn the distributor cam until the points are fully open.

STEP 4 Slide the feeler gauge through the contact point opening, as shown in Figure 9-17. The feeler gauge should just touch both contacts.

Figure 9-17 Measuring contact points gap with feeler gauge



Adjusting contact points will differ on some distributors, so several other methods are described below.

Figure 9-18 Adjusting point gap, using slot method

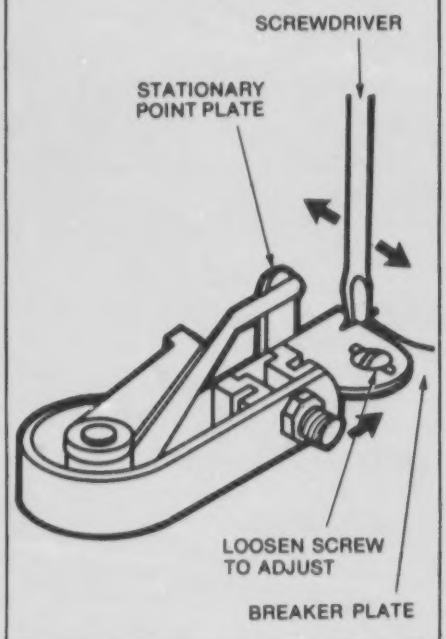
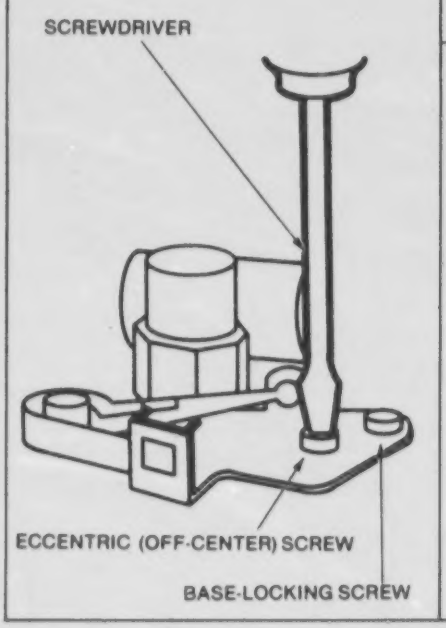


Figure 9-19 Adjusting contact point gap, using eccentric method



Using the slot method.

STEP 1 Loosen the base-locking screw of the stationary contact point, using a screwdriver (see Figure 9-18). Loosen it just enough so that the stationary point base can be moved.

STEP 2 Insert the screwdriver into the opening in the breaker plate assembly.

STEP 3 Slide the stationary point base in order to close or widen the gap. Check the opening with the feeler gauge.

STEP 4 Retighten the base-locking screw and check the gap opening again.

Using the eccentric method.

STEP 1 Loosen the base-locking screw of the stationary contact point just enough so that the stationary point can be moved (see Figure 9-19).

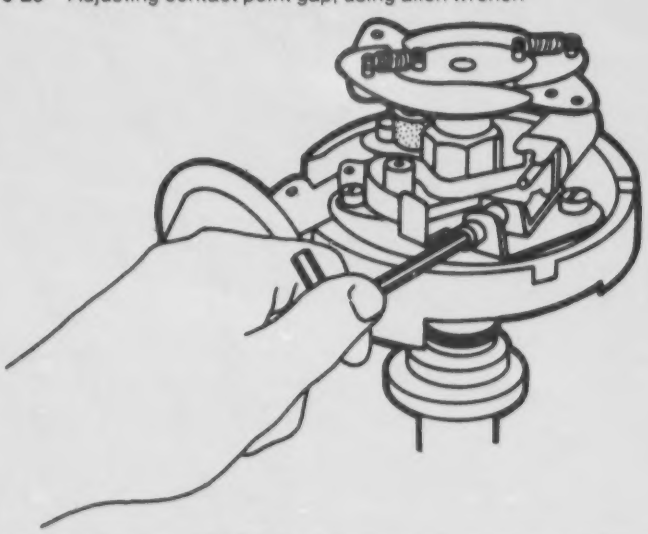
STEP 2 Using a screwdriver, turn the eccentric screw in either direction to move the stationary point base (see Figure 9-19). This closes or widens the point gap. Check the opening with a feeler gauge.

STEP 3 Retighten the base-locking screw, and check the gap opening again.

Using the allen wrench method.

STEP 1 Insert an allen wrench into the stationary contact point adjusting screw (see Figure 9-20).

Figure 9-20 Adjusting contact point gap, using allen wrench

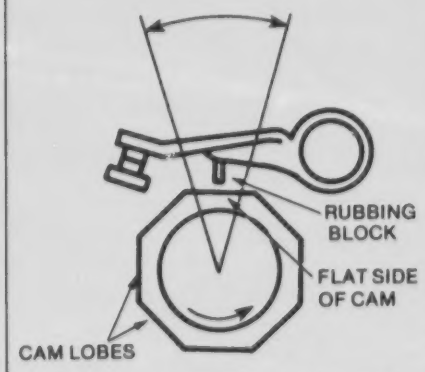


STEP 2 Turn the screw in either direction to move the stationary point base. This closes or widens the point gap. Check the opening with the feeler gauge. (You'll know that the contact point gap is correct if the feeler gauge just touches both contacts.)

Using the dwell meter method. Before measuring the point gap with a dwell meter, you must first become familiar with the term ***dwell.***

When the distributor contact points close, current flows through the coil primary winding, and electrical voltage builds up in the coil. During this period, the points are in a state of ***dwell,*** as shown in Figure 9-21. The terms ***dwell, dwell angle,*** and ***cam dwell*** or ***cam angle*** refer to the ***number of degrees the distributor cam rotates while the contact points are closed.***

Figure 9-21 Closed points in a state of *dwell*



As the distributor cam rotates, the contact points open whenever the high point of the cam pushes the rubbing block away. The amount of cam rotation between the points closing and the points opening is called the ***dwell*** of the points. Dwell is measured according to the number of degrees of cam rotation.

The high point of the cam is called the ***lobe*** or ***cam lobe.*** Usually, there is one lobe for each cylinder in the engine. On an 8-cylinder engine, there are 8 lobes on the distributor cam. There are 6 lobes on a 6-cylinder engine, and 4 lobes on a 4-cylinder engine (see Figure 9-22). On a V-8 engine, for example, the points open and close ***eight*** times for every ***one*** rotation of the distributor cam.

Figure 9-22 Cam lobes on 6-cylinder and 8-cylinder engines

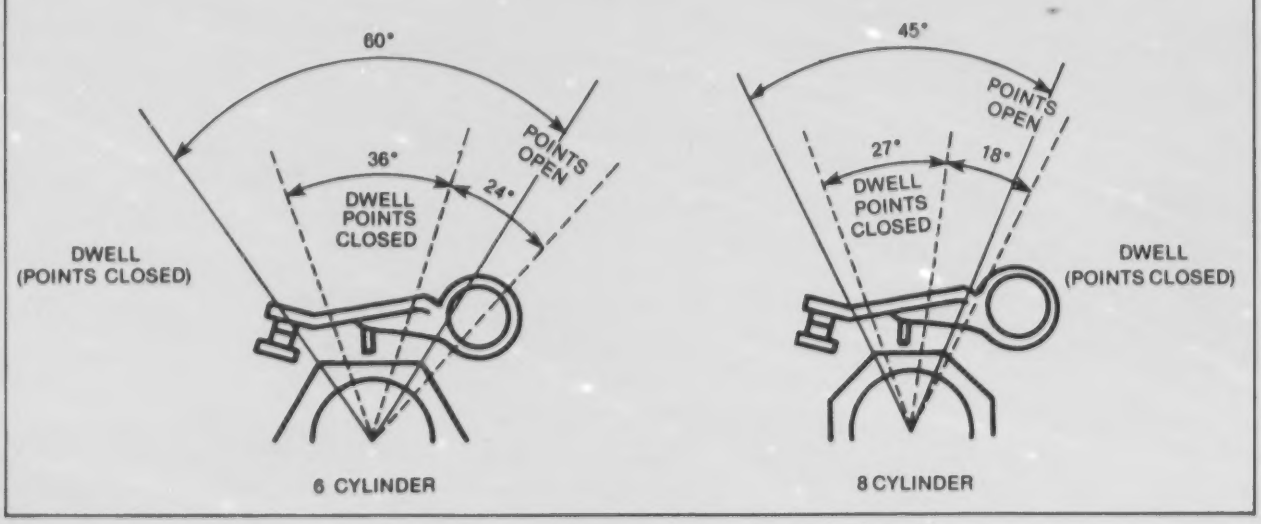


Figure 9-23 A wide point gap will decrease dwell and advance initial timing

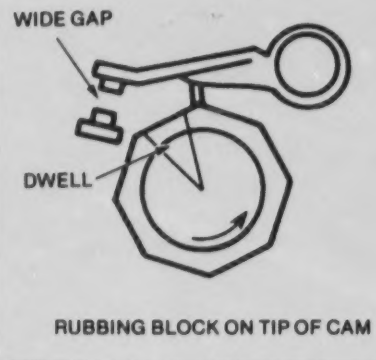
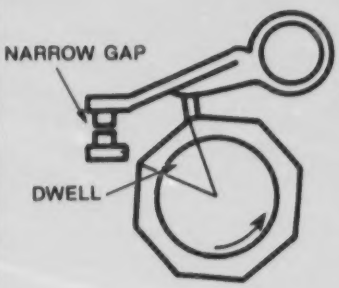


Figure 9-24 A small point gap will increase dwell and retard initial timing



On the 8-lobe cam shown, the points remain closed 27 degrees between the rotation of each cam lobe. So, dwell is 27 degrees. Note that cam lobes on a V-8 engine (shown in Figure 9-22) are 45 degrees apart. Dwell specifications for a V-8 engine are 27-32 degrees.

Note that on the 6-cylinder engine shown, the cam lobes are spaced 60 degrees apart. The dwell is 36 degrees. For 6-cylinder engines, dwell specifications are 31-42 degrees.

The ***wider*** the point gap, the ***shorter*** the time the points remain closed, as shown in Figure 9-23.

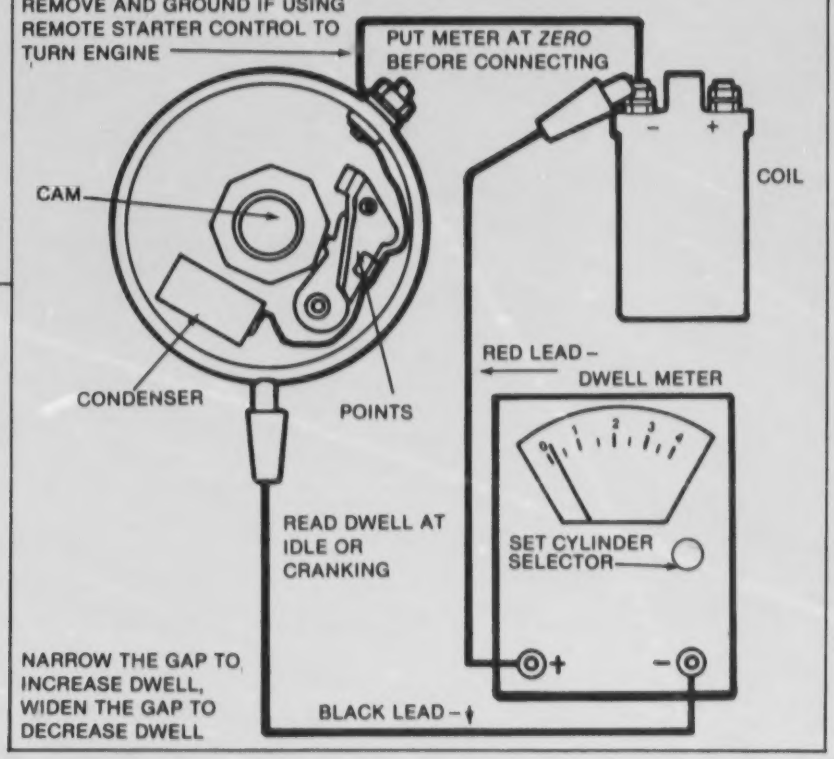
A wide point gap ***decreases*** the amount of dwell. So when the dwell meter shows a low reading, you know that the points have a wide gap.

The ***closer*** the point gap, the ***longer*** the points remain closed, as shown in Figure 9-24.

A small point gap ***increases*** the amount of dwell. So when the dwell meter shows a high reading, you know that the points have a small gap.

For used points, check the point adjustment with a ***dwell meter*** to get the most accurate reading.

Figure 9-25 Dwell meter hookup to set point dwell


REMOVE AND GROUND IF USING REMOTE STARTER CONTROL TO TURN ENGINE
PUT METER AT ZERO BEFORE CONNECTING
COIL
CAM
CONDENSER
POINTS
RED LEAD –
DWELL METER
READ DWELL AT IDLE OR CRANKING
SET CYLINDER SELECTOR
NARROW THE GAP TO INCREASE DWELL, WIDEN THE GAP TO DECREASE DWELL
BLACK LEAD –

To measure contact point adjustment by using a dwell meter, do the following:

STEP 1 Connect the ***positive (red) test lead*** of the dwell meter to the primary terminal (NEG (–) or DIST.) on the distributor side of the coil, as shown in Figure 9-25.

STEP 2 Connect the ***negative (black) ground lead*** of the dwell meter to the distributor housing. (Some dwell meter manufacturers suggest connecting the lead to a ground on the engine.)

STEP 3 If you are using a remote start switch to check the dwell at cranking speeds, disconnect the coil wire from the center of the distributor cap. Connect a jumper lead to the wire, and ground it so that the engine will not start. Turn on the ignition switch.

STEP 4 Set the dwell meter switch for a 4-, 6-, or 8-cylinder engine (see Figure 9-26).

STEP 5 Turn the dwell meter knob until the needle is on the ***set*** line on the scale, as shown in Figure 9-27.

Figure 9-26 Dwell meter switch

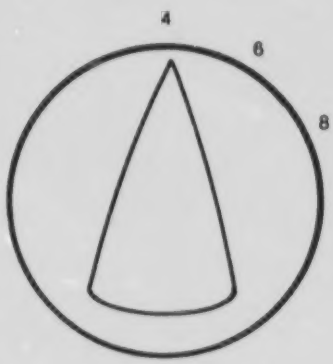
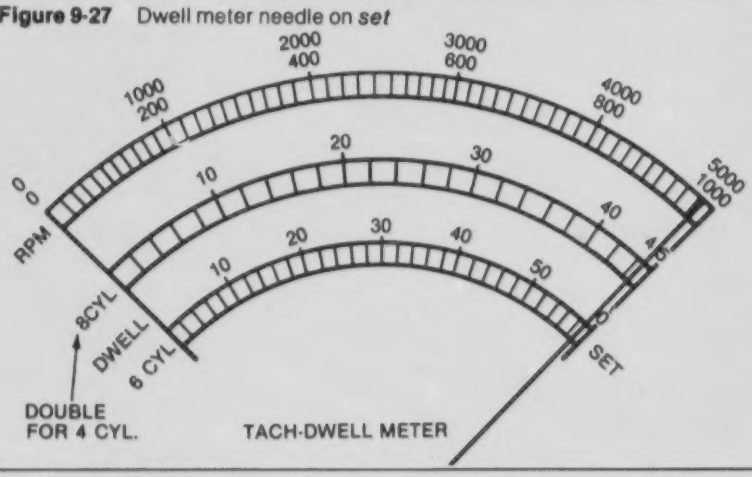


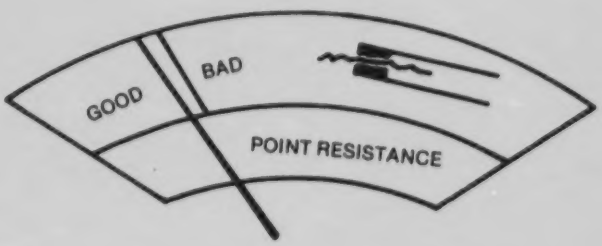
Figure 9-27 Dwell meter needle on *set*



STEP 6 Conduct the ***point resistance test.*** This test is very important because if there is resistance, it will affect the accuracy of the dwell reading. If the dwell test meter has a ***point res*** setting, move the switch to that position. Crank the engine until the points are closed.

NOTE: Point resistance on the dwell meter scale registers either ***good*** or ***bad*** (see Figure 9-28). Refer to Performance Objective 8 for the procedures you should follow when the meter needle reads ***bad.***

Figure 9-28 Point resistance reading on dwell meter



STEP 7 Look up the vehicle manufacturer's specifications for the correct dwell setting.

STEP 8 Unless the vehicle manufacturer specifies differently, disconnect and plug the ***vacuum hose*** that is connected to the distributor ***vacuum advance unit,*** as shown in Figure 9-29.

STEP 9 Operate the engine at cranking speed, and read the dwell setting of the contact points on the scale, as shown in Figure 9-30.

Figure 9-29 Plugging vacuum hose

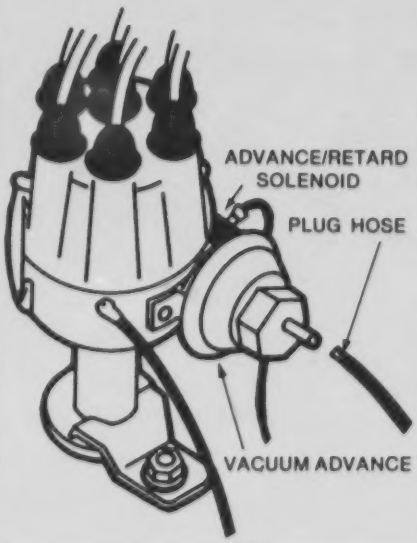
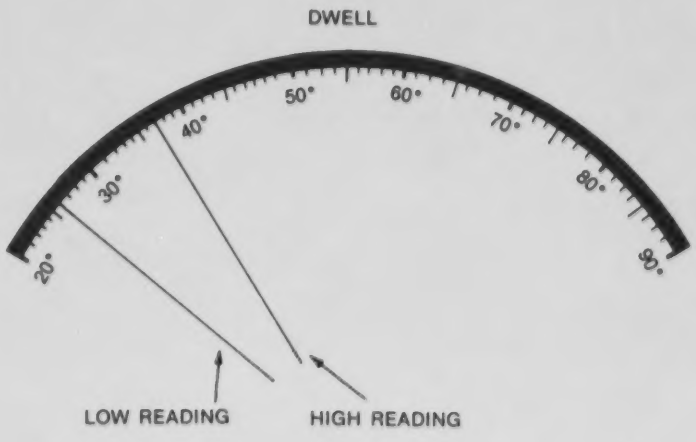


Figure 9-30 Dwell meter scale



CAUTION: Make sure the vehicle is in ***park*** or ***neutral*** before cranking the engine.

STEP 10 Compare the dwell reading to the one recommended by the vehicle manufacturer.

If the dwell reading is too ***low,*** the contact point gap is too ***wide.***

If the dwell reading is too ***high,*** the contact point gap is too ***small.***

To adjust the dwell of conventional two-piece contact points, do the following:

STEP 1 Turn the ignition switch off.

STEP 2 Loosen the contact point locking screw.

STEP 3 Turn the adjusting screw just a little.

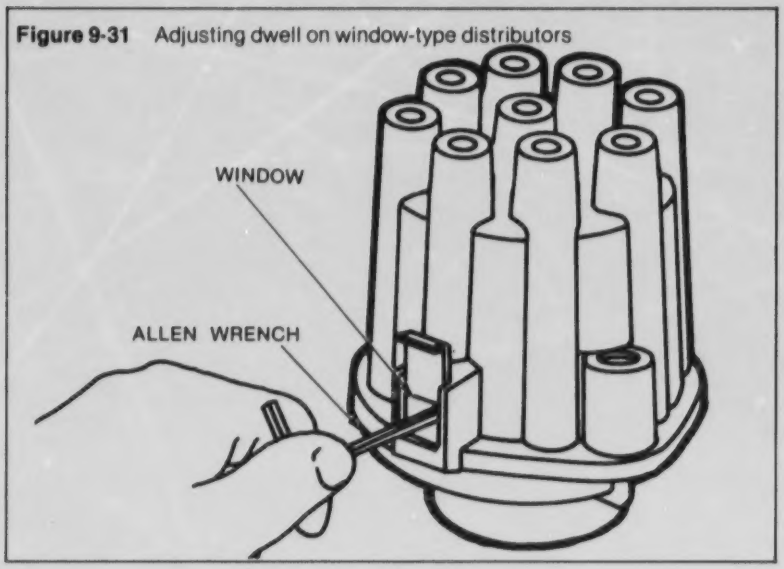
STEP 4 Retighten the locking screw and recheck the dwell. Turn the ignition switch ***on,*** and crank the engine.

STEP 5 Repeat Steps 2, 3, and 4 until the dwell reading matches the vehicle manufacturer's specifications.

STEP 6 Turn the ignition switch off, and reinstall the distributor rotor, distributor cap, and vacuum hose.

On those distributors with windows in the distributor caps, the contact points can be adjusted from outside the distributor, as shown in Figure 9-31. The rotor and cap stay in place and the engine operates at idle speed. A regular allen wrench or a special long and flexible tool with an allen wrench-type end is used to adjust the points.

Figure 9-31 Adjusting dwell on window-type distributors



To adjust the contact point gap on window-type distributors, do the following:

STEP 1 Raise the ***window*** on the side of the distributor cap.

STEP 2 Insert the allen wrench into the adjusting screw of the one-piece contact point set.

STEP 3 To adjust the contact points, start the engine and let it idle.

STEP 4 Turn the adjusting screw until the specified dwell shows on the dwell scale.

To adjust the dwell of dual contact points, do the following:

STEP 1 Remove the distributor cap and rotor.

STEP 2 Block out one set of contact points with a piece of clean cardboard, as shown in Figure 9-32.

STEP 3 Crank the engine, and take a dwell meter reading on the first set of points. Then, switch the piece of cardboard to the other set and repeat the procedure.

STEP 4 If both readings do not fall within vehicle manufacturer's specifications, adjust one or both sets until they do. (When adjusting one set, be sure to block out the other with the piece of cardboard.)

STEP 5 After both sets of contact points are adjusted, take a reading of the total dwell (both sets operating together).

STEP 6 Check the total dwell reading against the vehicle manufacturer's specifications. If the individual settings are correct, the total dwell should also be correct.

Figure 9-32 Adjusting dual contact points

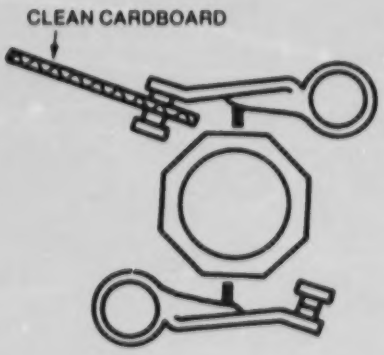
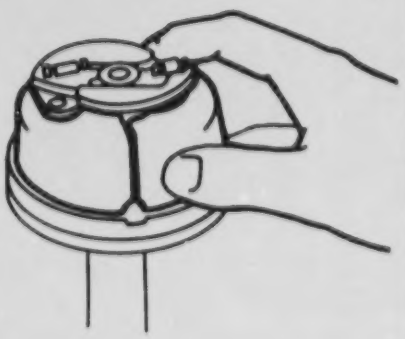


Figure 9-33 Installing the R.F.I. shield



Installing the R.F.I. Shield, Rotor, and Distributor Cap

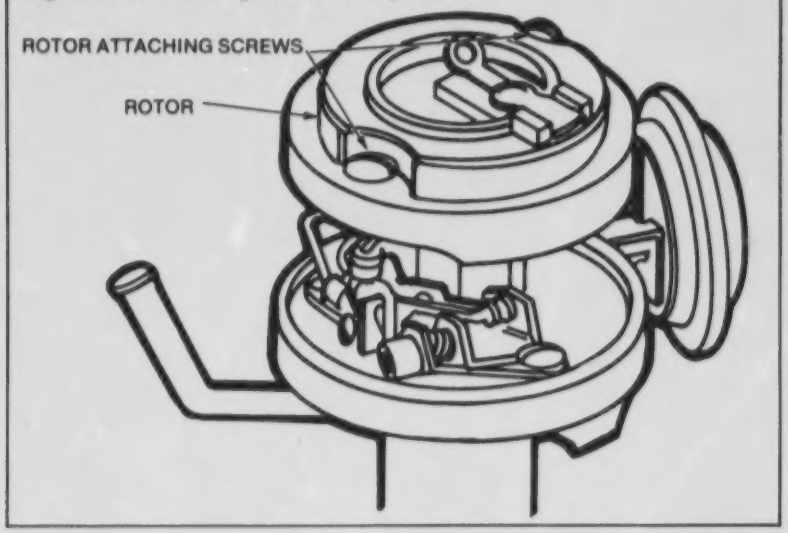
STEP 1 Install the second half of the R.F.I. shield. Install and tighten the R.F.I. shield locking screw.

CAUTION: Double-check to see that the wires inside are not touching the shield or any other parts.

STEP 2 Then, install the other half of the shield. Be sure it fits against the first half of the shield and is properly mounted as shown in Figure 9-33. Install the locking screw and tighten.

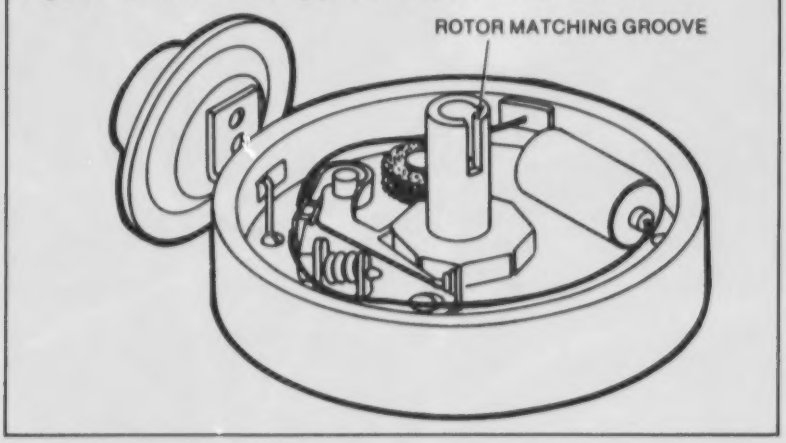
STEP 3 Place the rotor on top of the distributor shaft in the correct position. There is a round pin and a square pin on the underside of the rotor. Fit these pins into the matching round and square holes in the assembly plate at the top of the distributor shaft. Install the two attaching screws and tighten them securely (see Figure 9-34).

Figure 9-34 Installing rotor attaching screws



NOTE: On other kinds of rotors, align the inside ear of the rotor so that it interlocks with the groove at the top of the distributor shaft (see Figure 9-35). Fit it on the shaft and press downward. Make sure it locks squarely into place.

Figure 9-35 Rotor matching groove at top of distributor shaft



STEP 4 Guide the distributor cap over the rotor and align it with the distributor body. The hold-down clips or the latches should also align with their attaching parts.

STEP 5 Carefully turn the distributor cap back and forth until it snaps into place. (The top edge of the distributor housing fits into the bottom groove of the cap, which also has a locking tang.)

STEP 6 Then, snap the hold-down clips into the matching hold-down grooves in the side of the distributor cap.

STEP 7 On latch-type distributor caps, use a screwdriver to press downward on the latch. Then, turn the latch until it hooks into the groove on the body of the distributor housing. Do the same to the other latch.

Here is a review of the relationship between contact point gap and dwell:

1. a. A wide point gap produces a low reading on a dwell meter.
   b. The wider the point gap, the shorter the time the points remain closed.
   c. A wide point gap (or low dwell) delivers the spark *early* to the spark plug.
2. a. A small point gap produces a high reading on a dwell meter.
   b. The smaller the gap, the longer the time the points remain closed.
   c. A small point gap (or high dwell) delivers the spark *late* to the spark plug.

Turn to your Review Exercise Book and complete Exercise 7.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

2. Align the contact points. (pages 47-48)

3. Adjust the contact point spring tension. Record your results, and compare them with the vehicle manufacturer's specifications. (pages 48-49)

4. Adjust the contact point gap by using a feeler gauge. Record your results, and compare them with the vehicle manufacturer's specifications. (pages 49-50) *Check your work with your instructor.*

5. Adjust the contact point gap by using a dwell meter. Record your results, and compare them with the vehicle manufacturer's specifications. (pages 51-56) *Check your work with your instructor.*

After you have finished these activities, go on to the next section.

COMPLETING IGNITION AND CARBURETOR ADJUSTMENTS

You have now properly aligned the contact points, corrected the contact point spring tension, and adjusted the contact point gap to meet the manufacturer's specifications. You are ready to do the remaining ignition and carburetor adjustments that follow every contact point and condenser installation.

The next adjustment is to set the initial spark timing of the engine. (Initial timing refers to timing the engine ignition at engine idle RPM.) To set the timing, you must adjust the distributor. Then, you must readjust the carburetor idle speed and the idle mixture screws.

Ignition timing is one of the final steps in tuning an engine, and it is important to set it correctly. Incorrect ignition timing can lead to a loss of power, overheating of the engine, poor acceleration and performance, and too much fuel consumption.

Figure 9-36 Checking timing with timing light

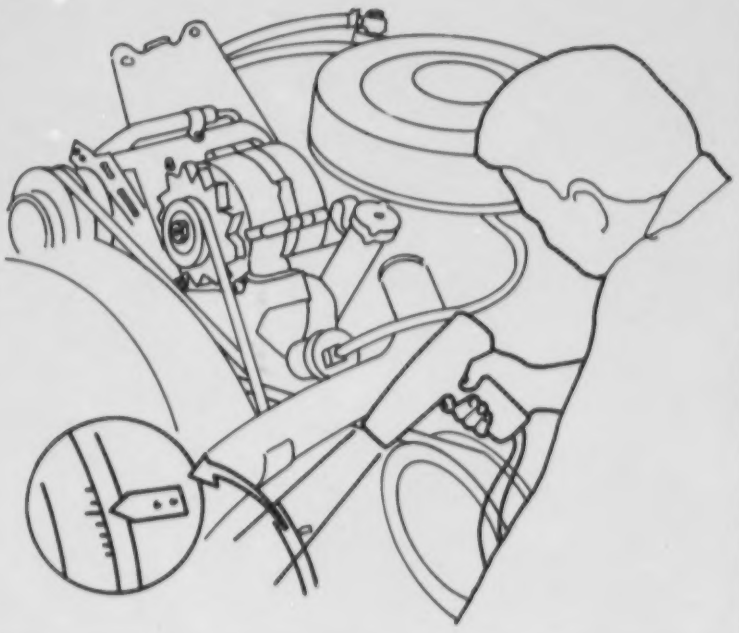


Figure 9-37 Spark timing

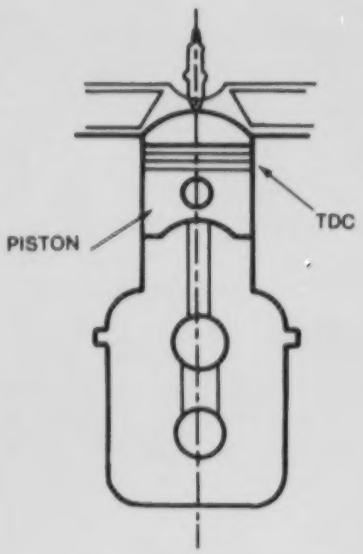
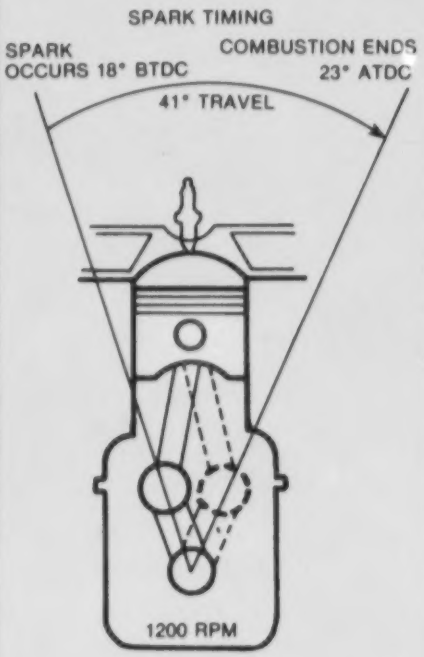


Figure 9-38 Piston at top dead center



The Meaning of Ignition Timing

A properly timed engine is one in which the spark created by the #1 spark plug at the #1 cylinder ignites the fuel-air mixture at precisely the right instant. The spark plug fires when the piston is on its way up (the compression stroke). Timing the spark plug to fire at this precise instant during the compression stroke is called ***spark timing***, or ***ignition timing*** (see Figure 9-37).

The ignition spark should ignite the fuel-air mixture when the piston is at top dead center (TDC) on its compression stroke. Top dead center is the upper limit the piston reaches as it moves in the engine cylinder, as shown in Figure 9-38.

As the engine speed increases, more lead time or ***advance*** is needed for the air-fuel mixture to burn before the piston reaches TDC. At lower engine speeds, less lead time is needed for the spark to fire. This is known as ***ignition timing.***

Generally, timing specifications are given as the number of degrees ***before*** the piston reaches top dead center ***(BTDC).*** The ***B*** in BTDC means that the spark must fire a certain amount of degrees ***before*** the piston reaches the top of its compression stroke. For example, a timing specification of 8° means that the spark must fire 8° before the piston reaches top dead center. However, some vehicles specify initial or basic timing settings at ***TDC.***

Preparation for Timing

Timing marks and reference pointers are usually located at the front of the engine on the crankshaft pulley. On some vans and light trucks, timing marks are located on the flywheel.

Some timing marks are located on the pulley, and the reference pointer is a fixed bracket on the engine, as shown in Figure 9-39.

Figure 9-39 Reference pointer is fixed bracket on engine

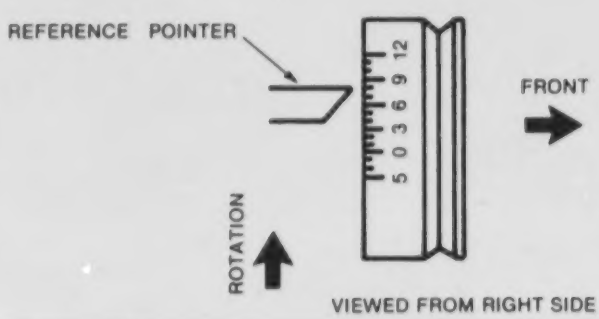
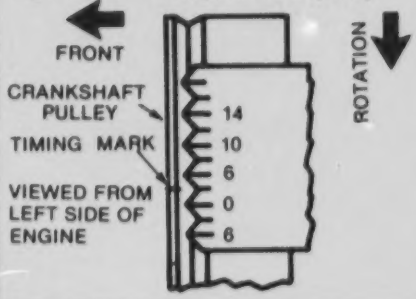


Figure 9-40 Timing marks on pulley



Some timing scales are located on the fixed bracket attached to the engine, and the timing marks are on the pulley, as shown in Figure 9-40.

STEP 1 Look up the vehicle manufacturer's timing specifications. Manufacturers publish timing specifications for each engine type.

You should be able to find them, as well as other tune-up specifications, on the Vehicle Emission Control Information decal located somewhere in the engine compartment (see figure 9-41). If not, check your technical service information manual.

Figure 9-41 Vehicle emission control decal

XZ
350-400 CU. IN.
2 BBL. CARB.
GM 104-2

VEHICLE EMISSION CONTROL INFORMATION
GENERAL MOTORS CORPORATION

AIR-EGR EXHAUST EMISSION CONTROL	TRANSMISSION	
	AUTOMATIC	MANUAL
DWELL	30°	30°
TIMING (° BTC @ RPM)	8° @ 600	0° @ 900
SOLENOID SCREW (RPM)	600 (DR)	900 (N)
BASE IDLE SCREW (RPM)	500 (DR)	500 (N)
LEAN DROP IDLE MIXTURE (RPM)	650-600 (DR)	1000-900 (N)
MAX. IDLE CO (% @ RPM)	0.5 @ 600 (DR)	0.5 @ 900 (N)

MAKE IDLE SPEED AND TIMING ADJUSTMENTS WITH ENGINE AT NORMAL OPERATING TEMP., CHOKE OPEN, AIR COND. OFF, AIR CLEANER INSTALLED, AND DISTR. VACUUM LINE DISCONNECTED AND PLUGGED. RECONNECT DISTR. VACUUM LINE WHEN ADJUSTMENTS ARE COMPLETED.

SET PARKING BRAKE AND BLOCK DRIVE WHEELS.

1. DISCONNECT FUEL TANK HOSE FROM VAPOR CANISTER.
2. ADJUST CARBURETOR SOLENOID SCREW TO SPECIFIED RPM.
3. SET DWELL AND TIMING AT SPECIFIED RPM. RESET IDLE SPEED IF NECESSARY.
4. ADJUST CARBURETOR IDLE CAM SCREW TO SPECIFIED BASE IDLE RPM ON LOW STEP OF CAM WITH SOLENOID WIRE DISCONNECTED. RECONNECT WIRE AFTER ADJUSTMENT.
5. IDLE MIXTURE HAS BEEN SET AT THE FACTORY. IF IDLE MIXTURE ADJUSTMENT IS NECESSARY, SEE SERVICE MANUAL FOR PROCEDURES. IDLE MIXTURE SPECIFICATIONS ARE SHOWN AT RIGHT.
6. REMOVAL OF MIXTURE SCREW CAPS AND/OR ALTERING IDLE MIXTURE TO OTHER THAN SPECIFICATIONS MAY VIOLATE FEDERAL AND OTHER STATE LAWS.
7. RECONNECT FUEL TANK HOSE TO VAPOR CANISTER.

SEE SERVICE MANUAL FOR ADDITIONAL INFORMATION FUEL REQUIREMENTS — USE 91 OCTANE OR HIGHER.

PRINTED IN USA THIS VEHICLE CONFORMS TO U.S. E.P.A. REGULATIONS APPLICABLE TO 1974 NEW YEAR MOTOR VEHICLES. PT. NO. 346258

Courtesy General Motors Corporation.

STEP 2 Wipe away all dirt and grease from both the reference pointer and the timing marks and scales. It is important to be able to see the markings clearly to obtain accurate timing results. (You may have to crank the engine until the marks are visible. Use a remote start switch, and ground the coil wire so that the engine will not start.)

CAUTION: The timing marks are close to the fan blades. Be careful not to get your hands too close to the fan blades while attempting to find or clean the timing marks!

NOTE: If the timing marks or reference pointer can not be seen clearly, use white paint or white chalk and make a thin line on the pointer and on the timing mark.

Reconnect the coil wire and disconnect the remote starter switch.

STEP 3 Locate the #1 spark plug.

The #1 cylinder is the key to timing an engine, so it is important to be able to locate the #1 spark plug. If you are not sure which spark plug or cylinder is #1, look it up in your technical service manual.

The #1 spark plug on V-8 engines is directly behind the radiator, either left or right, depending upon the make (see Figure 9-42).

On 4- and 6-cylinder engines, the #1 spark plug is also directly behind the radiator. These cylinders are always numbered in sequence from front to rear, as shown in Figure 9-43.

Figure 9-42 Locations of #1 spark plug on V-8 engines

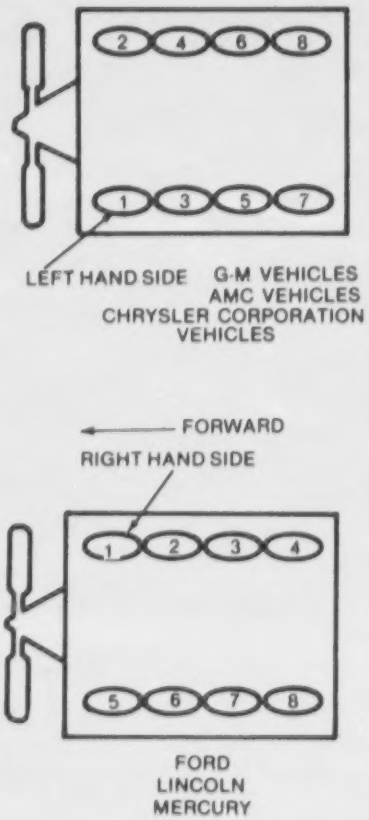


Figure 9-43 Location of #1 spark plug on 4- and 6-cylinder engines

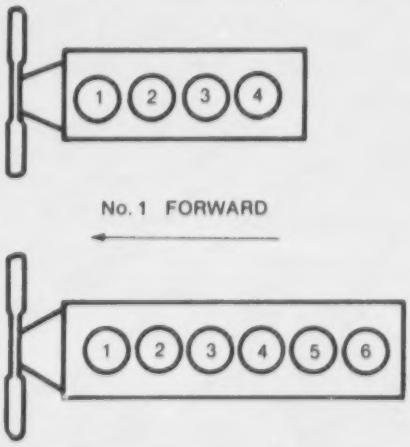
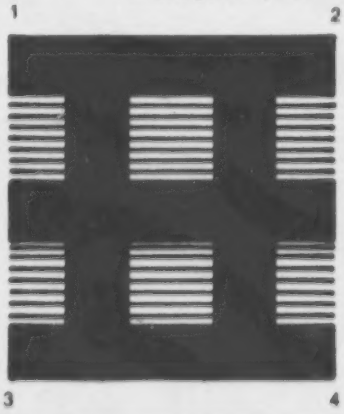


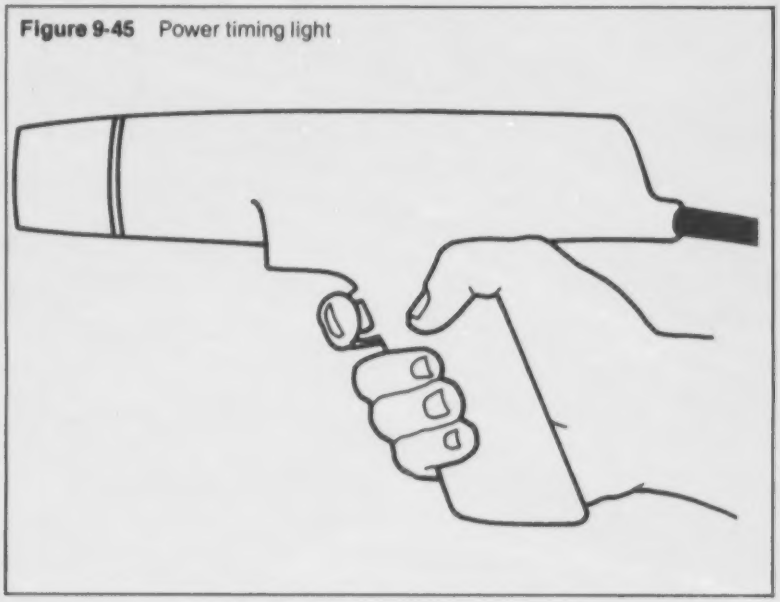
Figure 9-44 Spark plug order for Volkswagen engines



On all Volkswagen engines, the #1 spark plug is on the right-hand side as you look at the engine from the rear of the vehicle (see Figure 9-44).

Using Power Timing Lights

Figure 9-45 Power timing light



Timing lights are designed to flash at exactly the same instant that the #1 spark plug fires. Likewise, the timing marks at this instant indicate the proper location of the #1 piston. The very short length of each flash causes the moving mark on the pulley to appear as if it were standing still. Power timing lights have three leads: a red power cable, a black power cable, and an insulated high-voltage cable.

To hook up a power timing light, do the following:

STEP 1 With the ignition switch off, connect the ***red*** power lead to the ***positive*** (+) battery post. Connect the ***black*** power lead to the ***negative*** (−) battery post (see Figure 9-46).

Figure 9-46 Timing light hookup

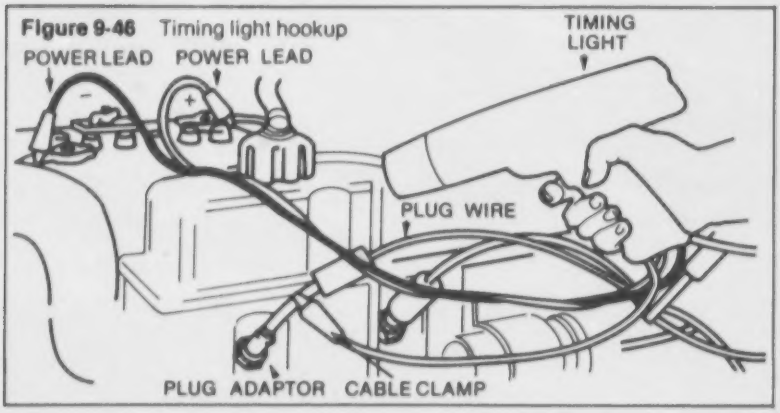


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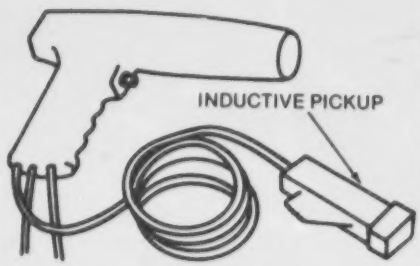
Figure 9-47 Timing light with inductive pickup



STEP 2 Remove the #1 spark plug wire and attach a spark plug adapter to the spark plug. (This adapter comes with the timing light.) Connect the spark plug wire to the adapter. Then attach the timing light insulated high-voltage cable clamp to the adapter.

Some timing lights use an ***inductive pickup coil*** to trigger the flash. Instead of disconnecting the spark plug wire and using a spark plug adapter, the mechanic simply snaps the inductive pickup around the #1 spark plug wire. The pickup can be placed at any point between the plug and the distributor cap (see Figure 9-47).

CAUTION: Always follow the manufacturer's directions for operating the timing light.

Using the Dwell Tachometer

Dwell meters are often combined with a tachometer in a single instrument housing, as shown in Figure 9-48. The tachometer is needed for setting correct engine idle speeds in late-model vehicles. It registers in RPM (revolutions per minute) of engine crankshaft rotation. During the timing procedure, the tachometer measures the rate of engine idle speed.

Figure 9-48 Dwell tachometer

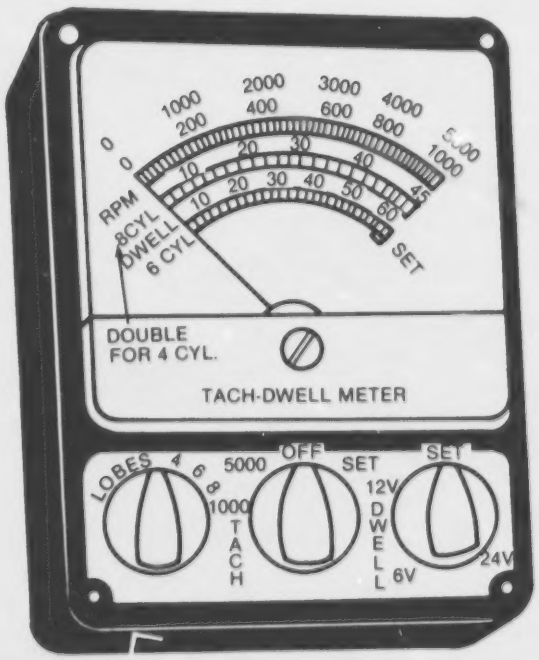


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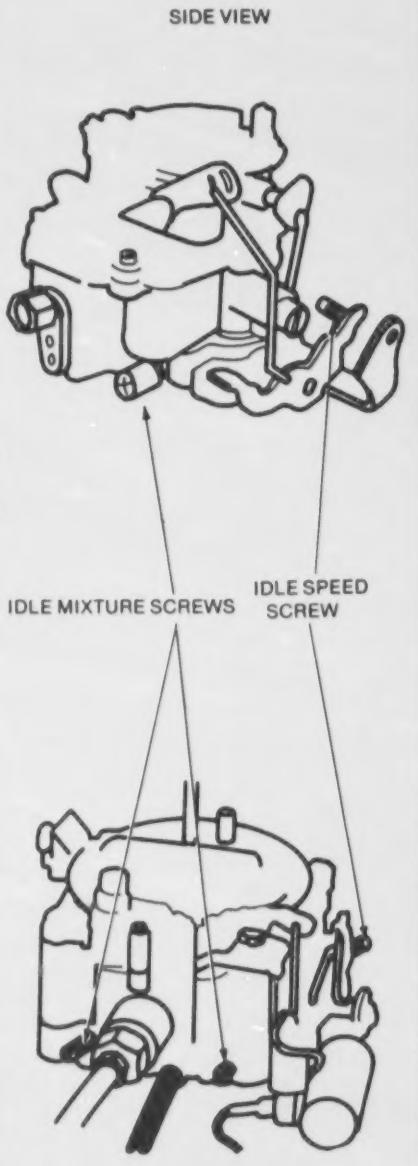
Figure 9-49 Location of idle speed screw



Initial timing is checked and adjusted at the specified engine idle speed. To find the specifications, refer to the Vehicle Emission Control Information decal in the engine compartment, or look it up in your technical service manual.

The dwell tachometer is left attached to the engine ignition system after contact point dwell checks and adjustments. Then, during the timing procedure, you can constantly check engine idle speed. The tachometer leads are attached to the engine in the same way the dwell meter leads are (see page 52 of this performance objective).

To test or adjust the initial timing, do the following:

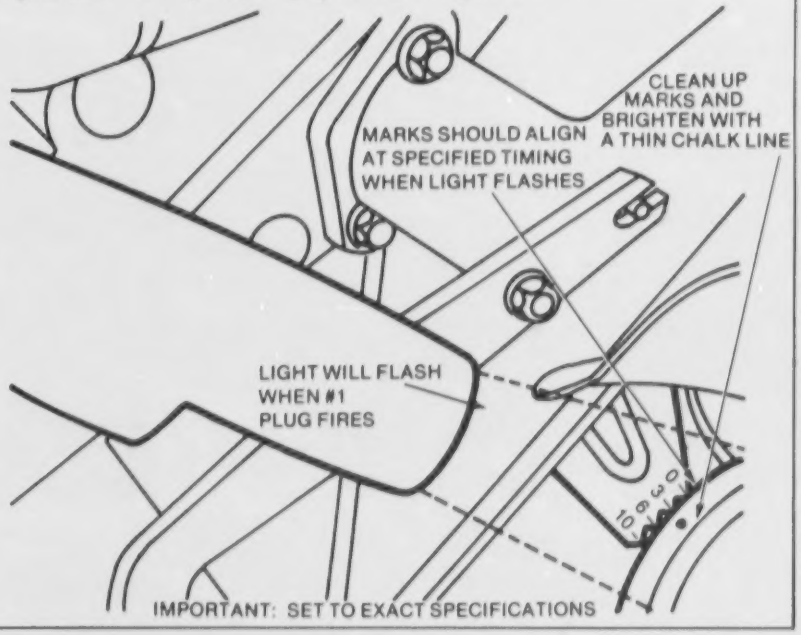
STEP 1 On the tachometer, turn the *tach* knob to the 1,000 RPM setting. For initial timing, engine RPM is read from the 1,000 RPM scale of the meter.

STEP 2 Start the engine and run it until it is at operating temperatures.

STEP 3 Set the engine RPM to the speed specified for initial timing. Adjust the idle speed screw on the carburetor throttle linkage to obtain the specified idle speed (see Figure 9-49).

STEP 4 Disconnect the distributor vacuum hose if specified. Plug the vacuum hose to prevent any engine idle RPM change. To plug the hose, insert an ordinary lead pencil into the vacuum hose.

Figure 9-50 Aiming the timing light at the timing marks


CLEAN UP MARKS AND BRIGHTEN WITH A THIN CHALK LINE
MARKS SHOULD ALIGN AT SPECIFIED TIMING WHEN LIGHT FLASHES
LIGHT WILL FLASH WHEN #1 PLUG FIRES
IMPORTANT: SET TO EXACT SPECIFICATIONS

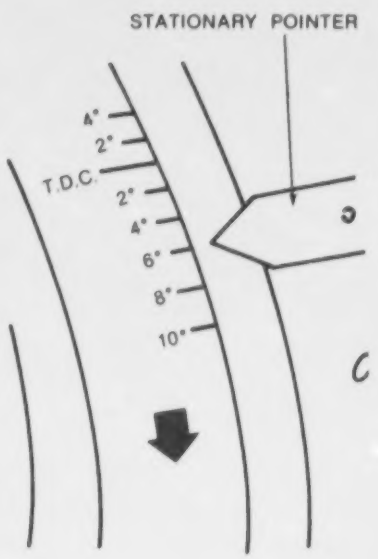


Figure 9-51 Moving mark exactly opposite pointer

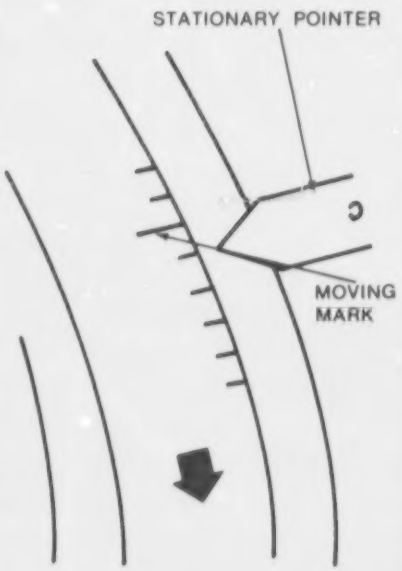


Figure 9-52 Pointer and moving mark not aligned

STEP 5 Aim the timing light at the timing marks and press the button, as shown in Figure 9-50. The flashing light should light up the timing mark and the stationary pointer. With the engine running at the specified idle speed, the timing mark should align at the correct setting when the light flashes.

Here is a review of the steps in preparing for the timing procedure:

1. Clean and brighten the timing marks.
2. Set the dwell to specifications ***before*** checking the timing.
3. Make sure the vacuum lines are disconnected from the distributor and plugged.
4. Make sure the engine is operating at manufacturer's idle specifications.
5. Make sure timing is exactly at engine decal specifications.

CAUTION: Keep your hands and the timing light away from the fan blades while timing the engine. Personal injury and/or damage to parts can result.

Reading the Engine Timing

Note the position of the timing marks. The engine is ***in time*** only if the timing mark is positioned exactly opposite to the stationary pointer, as shown in Figure 9-51.

This means that at this point the distributor contact points begin to open and the #1 spark plug fires.

However, if the timing mark is positioned at one side or the other of the stationary pointer, the engine is ***out of time,*** as shown in Figure 9-52.

If the mark and reference pointer do not line up as specified, the distributor body must be rotated until they do line up.

Adjusting the Ignition Timing

STEP 1 Loosen the hold-down bolt located at the base of the distributor (see Figure 9-53).

Figure 9-53 Location of hold-down bolt

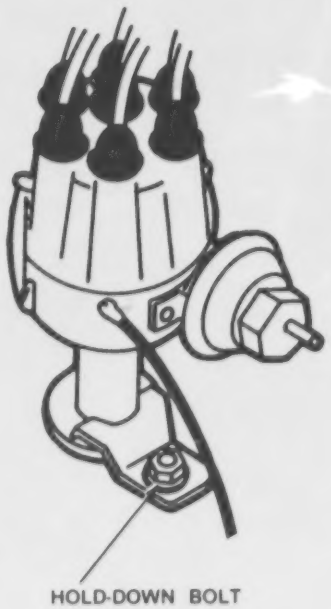
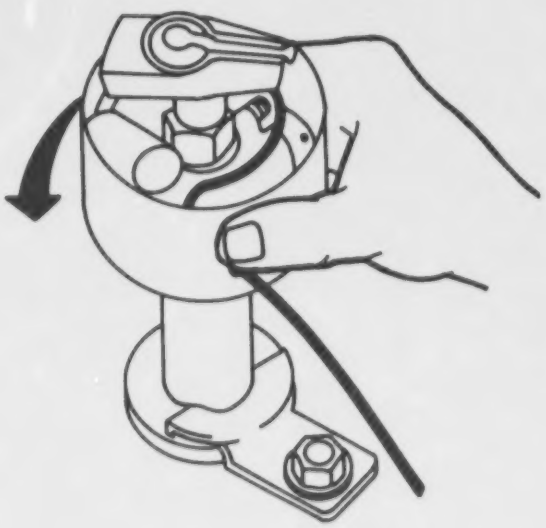


Figure 9-54 Special offset wrench used to loosen hold-down bolt

NOTE: Distributors on many late-model V-8 engines require a special offset wrench to reach the hold-down bolt (see Figure 9-54).

STEP 2 Slowly turn the distributor to align the timing mark with the reference pointer (see Figure 9-55). Then, tighten the distributor hold-down bolt and recheck the timing with the timing light.

Figure 9-55 Turning the distributor to adjust the timing



STEP 3 Then, adjust the idle mixture screw for the highest steady RPM reading. If the carburetor has two idle mixture screws, adjust each one equally (first ***in,*** then ***out***) until the highest steady RPM is reached.

NOTE: The ***idle speed screw*** may have to be readjusted if adjusting the mixture screws changes the idle speed.

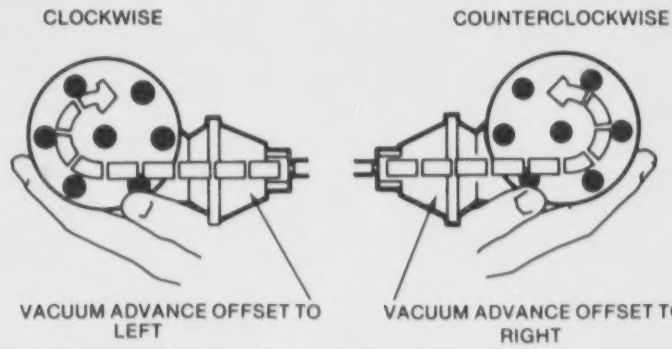
The ignition timing must be set exactly as specified by the vehicle manufacturer. Poor timing defeats the purpose of emission control devices and causes the engine to give off illegal amounts of pollutants.

When turning the distributor to adjust the timing, remember that turning the distributor body in the same direction as the rotor rotation ***retards the spark or timing.*** Turning it in a direction opposite to rotor rotation ***advances the spark or timing.***

To know the direction that the rotor rotates, check the vehicle manufacturer's specifications. If this information is too difficult to locate, here is a rule of thumb you can follow on the job:

The vacuum advance unit is offset to either the right or left of the distributor housing, as shown in the two illustrations in Figure 9-56. You can find the distributor rotation direction by pointing your finger along the vacuum advance unit so that the curve of your finger matches the curve of the distributor housing. ***The direction that your finger points will be the direction of the distributor shaft, cam, and rotor rotation.***

Figure 9-56 Using hands to determine rotor rotation



If a finger of your left hand follows the curve of the housing, rotation is *clockwise.*

If a finger of your right hand follows the curve, rotation is *counterclockwise.*

STEP 4 Turn off the engine and disconnect the timing light and dwell tachometer. Reconnect the distributor vacuum hose. This completes the ignition timing.

Turn to your Review Exercise Book and complete Exercise 8.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

6. **Adjust the ignition timing. Record your results and compare them with the vehicle manufacturer's specifications. (pages 63-68)** *Check your work with your instructor. instructor.*

7. **Reset the engine idle speed. Record your results and compare them with the vehicle manufacturer's specifications. (pages 68-69)** *Check your work with your instructor.*

When you have finished these activities, ask your instructor to return your pretest on Performance Objective 9. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will then tell you if you are ready to be checked off on the performance checklist or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

PERFORMANCE OBJECTIVE 10

REMOVE AND INSTALL THE DISTRIBUTOR

INTRODUCTION TO P. O. 10

In this performance objective you will learn how to remove and install a distributor.

You may want to review Performance Objective 9, which covers contact point dwell, ignition timing, and procedures for adjusting engine idle RPM.

After you have finished all the work activities for Performance Objective 10, your instructor will use a checklist like the one below to evaluate your work.

Performance Checklist—P.O. 10

The instructor will provide either a live vehicle or a live engine. Remove and install the distributor. All of the performances below must be accomplished.

Student Performances	Instructor Ratings		
	Acceptable	Not Acceptable	Omit
1. Disables the ignition.			
*2. Cranks engine until the timing marks align.			
*3. Marks the appropriate positions on the distributor body, cap, and engine block, as necessary.			
4. Removes the hold-down screw and plate.			
5. Removes the distributor from the engine.			
*6. Marks the last position of the rotor.			
7. Installs the distributor in the engine.			
8. Replaces the hold-down plate and bolt.			
9. Replaces all leads.			
10. Adjusts the dwell, engine idle, and timing.			
11. Uses the proper tools and equipment.			
12. Follows appropriate safety precautions.			
13. Performs tasks in an acceptable amount of time.			

SAMPLE

*The instructor may omit these steps in order to see if the student can install a distributor without the benefit of markings.

Tools and Equipment

For this objective, you will need to use the tools and equipment listed below. You will be given the procedures for using special tools and equipment as you work through the activities.

Basic Hand Tool Set

Special Hand Tools

distributor wrenches
distributor point aligning tool

Basic Equipment

fender covers
extension light
timing light
dwell meter
tachometer
remote control start switch
points spring tension gauge

Special Equipment

distributor puller

Reading List

If you would like additional information as you work through this performance objective, use the references below.

General References

Crouse, *Automotive Mechanics,* p. 320.

Crouse, *The Auto Book,* pp. 267, 342-44, 366-67.

Ellinger, *Automechanics,* pp. 291-92.

Stockel, *Auto Mechanics Fundamentals,* pp. 62-63.

Toboldt and Johnson, *Automotive Encyclopedia,* p. 407.

Special-Purpose Reference

Crouse, *Automotive Electrical Equipment,* pp. 232-34.

Personal and Service Safety Practices

Safety When Working Around the Distributor

Fender covers. Always use fender covers when working under the hood. This keeps the fenders from getting scratched.

Distributor cap. Always wipe the distributor cap and surrounding area clean before removing the cap. This prevents dirt from getting inside the distributor.

Personal safety. Do not reach into the engine compartment without looking first. You can be injured by moving parts.

Keep your hands away from the fan and fan belt while the engine is operating. You can be injured.

Timing light. Be careful when using the timing light near the engine fan blades. You can damage the timing light.

Safety When Making an Electrical Test

Correct procedures. Follow the manufacturer's procedures for using electrical test equipment. This includes the procedures for the proper care and use of the equipment as well as instructions for making equipment calibrations.

Personal safety. *Never* do any electrical test when standing on a wet floor or when vehicle or engine parts are wet.

Safety in Work Clothing and Grooming

Hair. Keep hair away from moving parts. If your hair hangs below your collar, wear a hat.

Jewelery. Avoid wearing any metal (rings, buckles, wrist-watches, necklaces) that can come in contact with electrical parts.

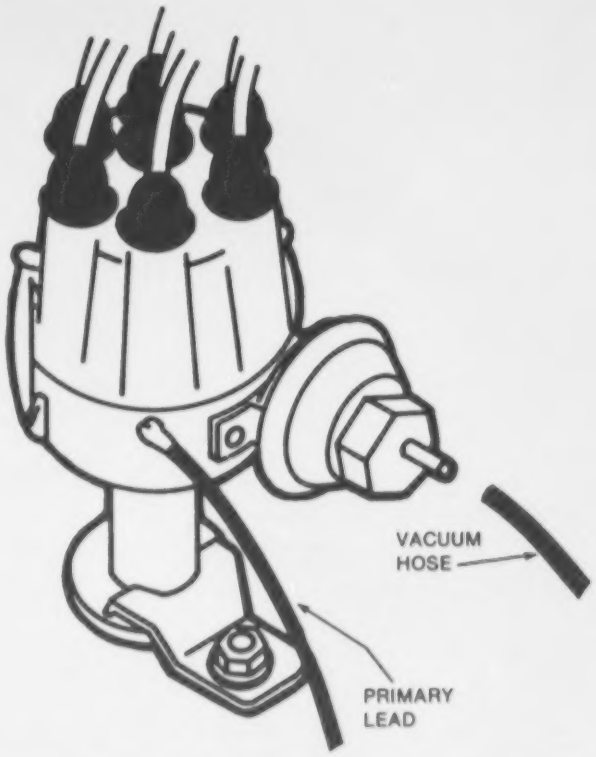
Clothing. Avoid wearing loose clothing, since it can get caught in equipment and cause serious injury.

REMOVING AND INSTALLING THE DISTRIBUTOR

Removing the Distributor

STEP 1 Disconnect and plug the vacuum hose (see Figure 10-1). If there is more than one hose, remove them all, but be sure to mark them properly with masking tape. Marking them will help you to reinstall them correctly.

Figure 10-1 Vacuum hose disconnected from distributor vacuum unit



STEP 2 Disconnect the distributor-to-coil primary lead. For many distributors, you will have to disconnect the lead at the coil end.

STEP 3 For some distributors, it will be necessary to disconnect the advance/retard solenoid lead at the carburetor.

STEP 4 Connect the remote start switch to the starter relay or solenoid. For the hookup of the remote start switch, see Performance Objective 8.

Figure 10-2 Proper alignment of the timing mark

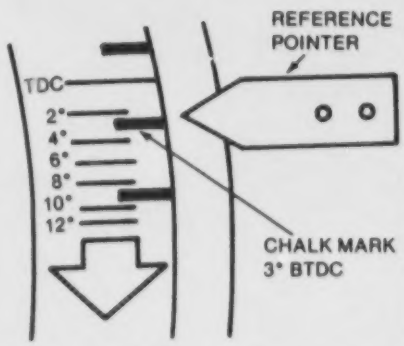
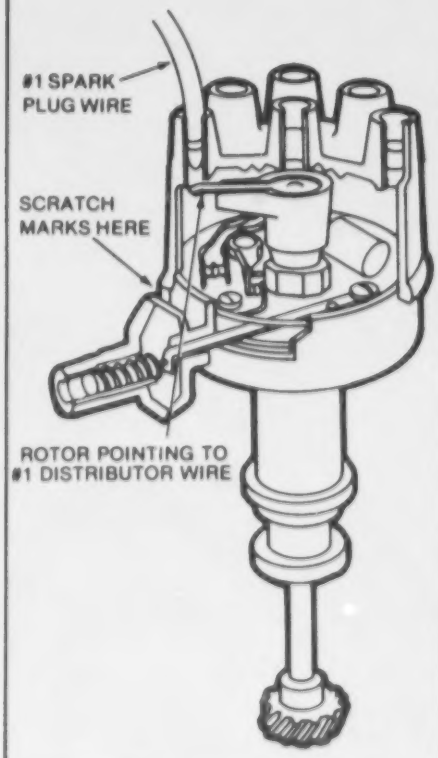


Figure 10-3 Distributor with #1 spark plug wire identified



STEP 5 Look up the vehicle manufacturer's specifications for the location of the timing marks. These specifications can be found on the Vehicle Emission Control Information decal in the engine compartment.

STEP 6 Crank the engine with the remote start switch until the timing marks are aligned to manufacturer's specifications, as shown in Figure 10-2.

STEP 7 Clean the timing marks and make a thin stripe over the correct mark with white paint or a white piece of chalk.

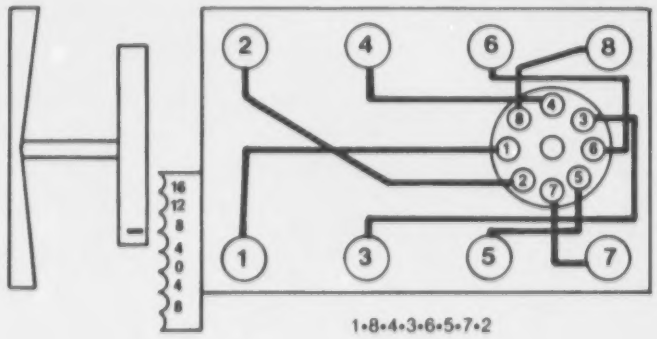
STEP 8 Trace the #1 spark plug wire back to the distributor and note its location on the distributor cap (see Figure 10-3). Mark the location of the #1 spark plug wire at the lower edge of the cap and on the distributor body.

STEP 9 Remove the distributor cap. The rotor should be pointing to the #1 spark plug wire in the distributor cap. If it is not, watch your timing marks, and crank the engine until the timing marks line up again. ***The rotor must be pointing to the #1 spark plug wire when the timing marks line up*** (see Figure 10-3).

If you have difficulties aligning the rotor with the #1 spark plug wire, check the technical service manual. Locate the illustration of the #1 spark plug wire on the distributor cap. All the locations of the spark plug wires in the distributor cap should match the illustrations in the manual.

Figure 10-4 shows an example of spark plug wire locations on the distributor cap.

Figure 10-4 Example of spark plug wire locations

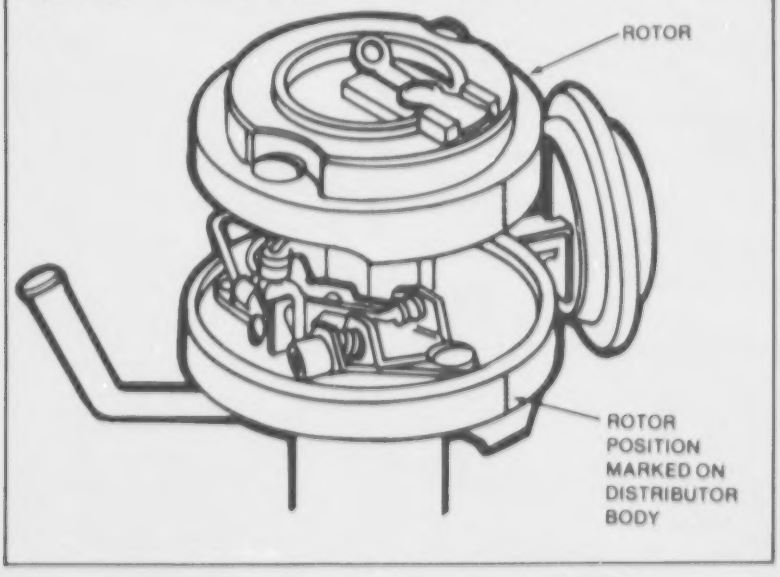


If the #1 spark plug wire is not in the same location as shown in the illustration, you will have to remove all the wires and reposition them correctly.

When you reinstall the distributor, follow the installation directions on page 81 of this performance objective.

STEP 10 Mark the distributor body at a point in line with the tip of the rotor (see Figure 10-5). This will help you to align the rotor with the #1 spark plug wire when you reinstall the distributor.

Figure 10-5 Distributor body marked in line with rotor



STEP 11 Mark the body of the distributor at its base, and place a matching mark on the engine block. This will help you to reinstall the distributor in its original timing location. To mark the distributor base and engine block, use white paint or a center punch.

NOTE: Be sure to notice the position of the distributor in the engine block. You can do this by looking along the distributor vacuum unit and noting its relationship to the other engine parts.

STEP 12 Remove the distributor hold-down bolt and the distributor hold-down clamp (see Figure 10-6). Because of the difficult location of the bolt, it may be necessary to use a special offset distributor wrench.

STEP 13 Remove the distributor from the engine block. Occasionally, the distributor may be stuck and difficult to lift out.

Figure 10-6 Removing distributor from engine block

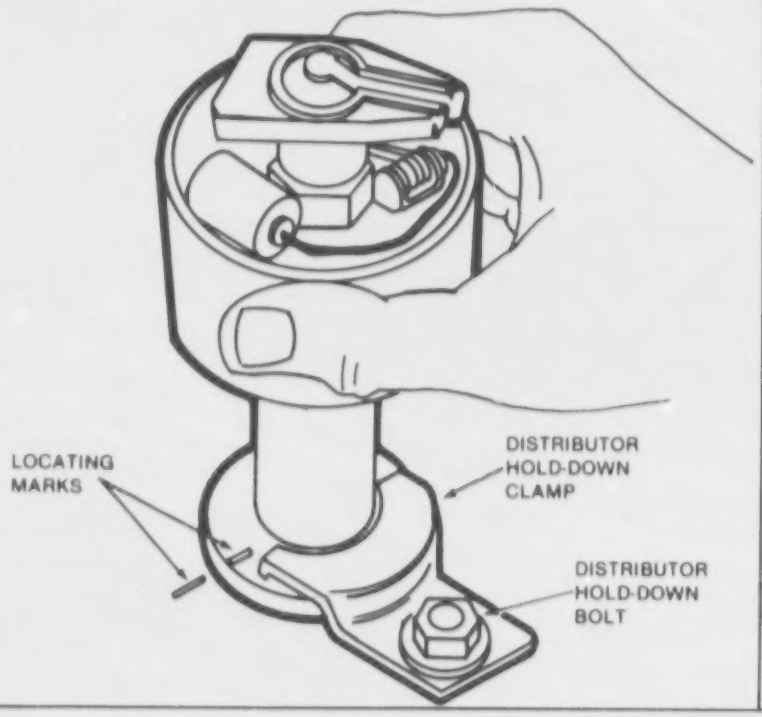


Figure 10-7 Distributor puller

It may be necessary to use a ***distributor puller*** to break the distributor loose from its mounting (see Figure 10-7). If a distributor puller is not available, use a soft hammer and lightly tap against the distributor body. An antirust solvent applied around the base of the distributor may help also.

If the distributor has a drive gear at the end of the distributor shaft, the rotor will rotate as the distributor is pulled out of the block.

On distributors that do not have drive gears, the rotor will ***not*** turn to a new position.

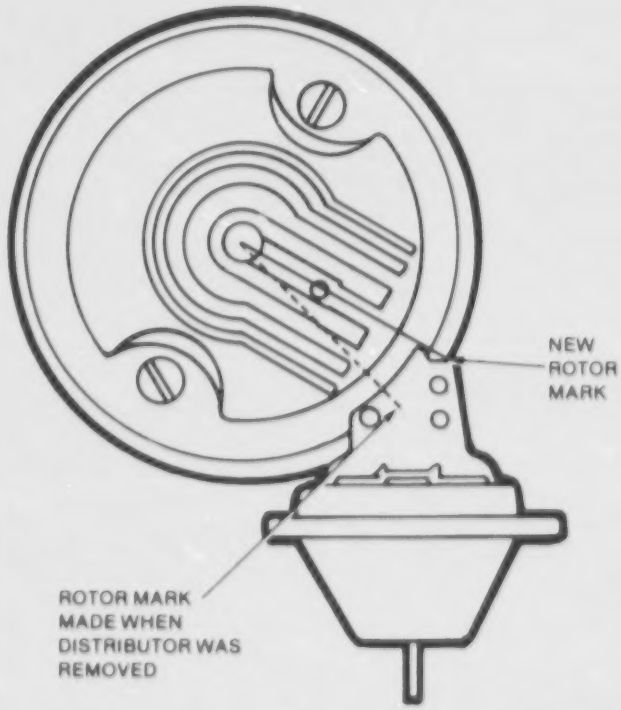
STEP 14 Mark the last position of the rotor, as shown in Figure 10-8. Do this by placing a mark on the distributor body as before, but align it with the new position of the rotor.

STEP 15 Remove the gasket between the distributor and the engine block.

NOTE: Always set the distributor in an upright position so that the oil from the distributor shaft will not run out into the breaker plate and contact points.

81

Figure 10-8 Marking last position of rotor



At this point, remove the ignition key from the vehicle. This will prevent someone from accidentally cranking the engine. Cranking the engine at this point will upset the timing mark location, which will change the position of the rotor in relation to the #1 spark plug wire.

Turn to your Review Exercise Book and complete Exercise 9.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

1. **Mark the location of the #1 spark plug wire on the distributor cap and distributor body. (page 77)**
2. **Mark the rotor position in relation to the #1 spark plug wire, engine timing marks aligned. (pages 77-78)**
3. **Mark the distributor base and the engine block. (page 78)**
   Check your work with your instructor.
4. **Remove the distributor from the engine. (pages 78-80)**
   Check your work with your instructor.

After you have finished with these activities, go on to the next section.

Installing the Distributor

The procedures for ***installing*** the distributor are the same as those for ***removing*** the distributor, but are done in reverse order. You must be very careful to align the marks you made when you removed the distributor. This will ensure proper engine operation when you finish installation.

STEP 1 Install the distributor gasket on the engine block.

STEP 2 Turn the rotor on the distributor until its tip aligns with the ***last*** marking you made on the distributor body, as shown in Figure 10-9.

STEP 3 Install the distributor on engine block. ***Carefully*** slide the distributor down into position.

As the distributor drive meshes with its matching gear, the rotor will turn and stop at the ***first*** marking you made on the distributor body.

STEP 4 Turn the distributor body until the locating mark on the base of the distributor aligns with its matching mark on the engine block (see Figure 10-10).

Make sure the distributor housing is fully seated against the cylinder block. If it's not, refer to page 83 of this performance objective for instructions on what to do.

At this time, make sure the rotor tip is aligned with the first mark you made on the distributor body, as shown in Figure 10-11. If it's not correctly aligned, remove the distributor and start over again.

Figure 10-9 Checking marks when installing rotor

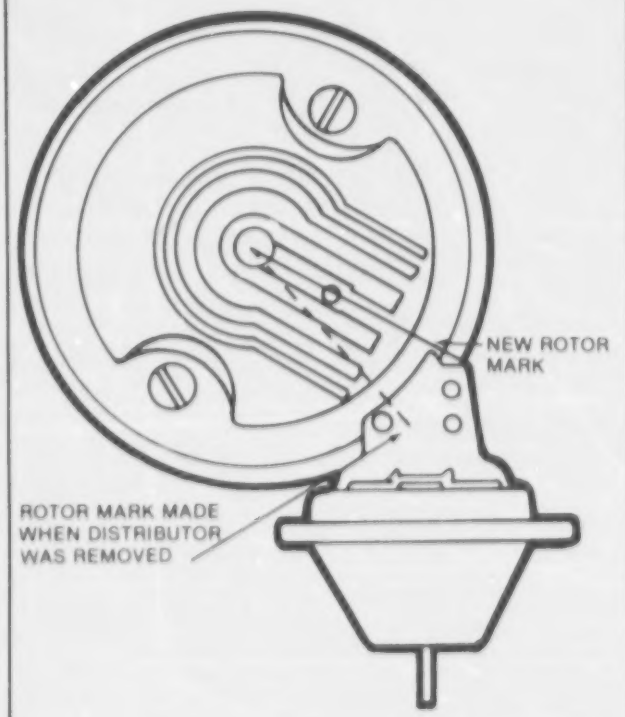


Figure 10-10 Aligning distributor with locating marks

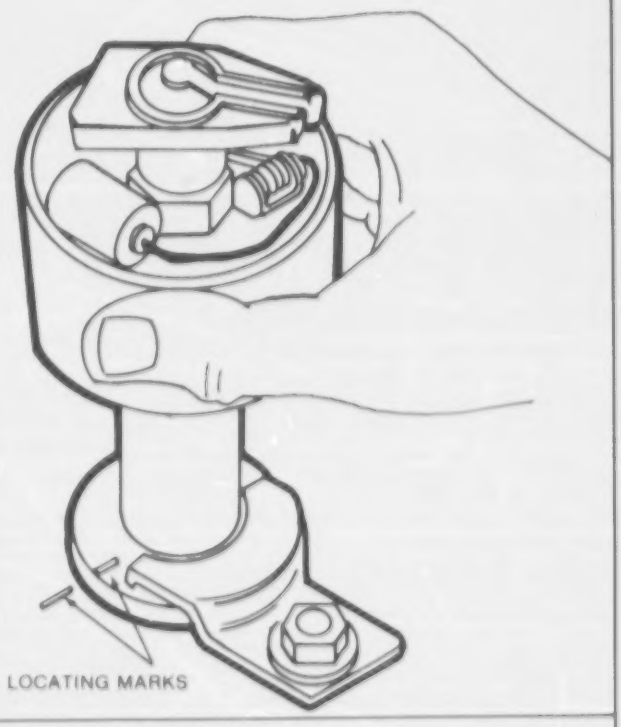
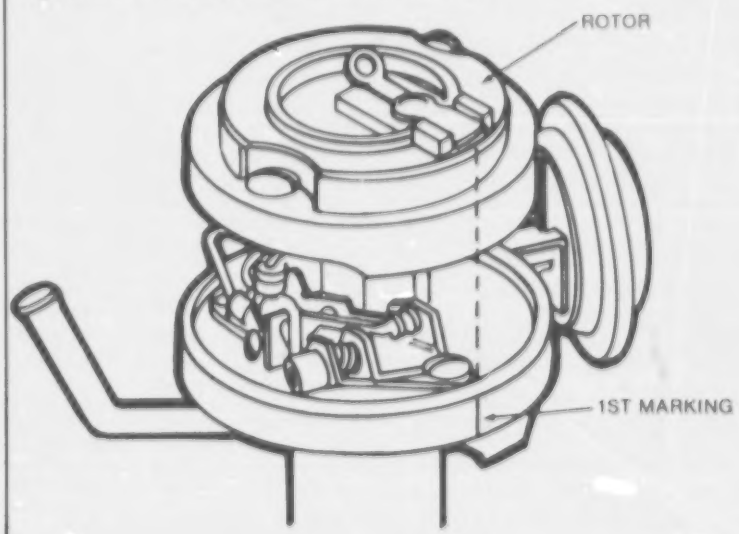


Figure 10-11 Aligning rotor with first marking



When all marks are in alignment, it means that:

1. The rotor is aligned with the #1 spark plug wire in the distributor cap.

2. The distributor base is positioned at its original timing adjustment.

3. The engine timing marks are aligned.

STEP 6 Install the distributor hold-down clamp and bolt. Tighten the bolt until it is just snug. This will keep the distributor from turning until you are ready to time the engine.

STEP 7 Attach the distributor-to-coil primary wire. Also, if the engine is equipped with an advance/retard solenoid lead, connect it to the carburetor.

STEP 8 Install the distributor cap to complete the distributor installation procedures. (The vacuum hoses are left off until the contact point dwell and the ignition timing adjustments are completed.)

Remember: The vacuum hose or hoses must be ***plugged*** before timing the engine.

Checking Engine Performance

Once the distributor is installed in the engine, you must make a few final adjustments to make sure the engine performs to the vehicle manufacturer's specifications. The following adjustments must be done to complete distributor installation. Before you begin the following adjustments, make sure that you have: plugged the distributor vacuum hose or hoses, attached the dwell tachometer, and hooked up the timing light according to manufacturer's specifications.

Contact Point Dwell Adjustment

For the correct procedures, review Performance Objective 10.

Ignition Timing Adjustment

For the correct procedures, review Performance Objective 10.

Resetting Engine Idle RPM

For the correct procedures, review Performance Objective 10.

After you have completed these procedures:

1. Disconnect the timing light, dwell tachometer, and remote start switch.

2. Reconnect the vacuum hose or hoses to their proper fittings.

3. Clear your work area of tools and equipment and return them to their proper place.

Turn to your Review Exercise Book and complete Exercise 10.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

5. Install the distributor in the engine. (pages 81-84) *Check your work with your instructor.*

6. Adjust the contact point dwell and ignition timing, and reset the engine idle speed. (pages 60-69) *Check your work with your instructor.*

After you have finished these activities, go on to the next section.

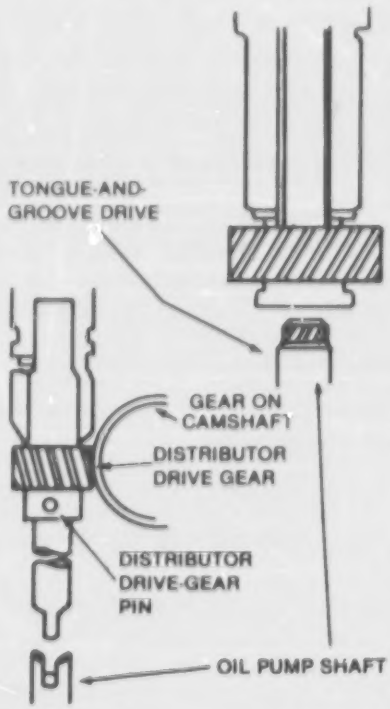


Figure 10-12 Two examples of distributors with drive gears

Installing the Distributor without Using Markings

Occasionally a distributor has been removed before the rotor position is properly marked. And, sometimes the engine has been cranked accidentally while the distributor was out of the engine. If either situation should occur, the distributor may be installed by the following method:

STEP 1 Remove the #1 spark plug.

STEP 2 Place your finger over the spark plug hole and crank the engine, using the remote start switch until you feel compression pressure on your finger. When you can feel the pressure, stop cranking the engine.

STEP 3 Check to see that the timing marks are aligned to manufacturer's specifications. If not, crank the engine a little at a time until the marks are aligned.

STEP 4 Locate the #1 spark plug wire connection in the distributor cap.

STEP 5 Now, install the distributor in the engine. On distributors that have a drive gear, rotate the rotor slightly so that its final position will line up on the #1 spark plug wire in the distributor cap (see Figure 10-12).

NOTE: If the distributor is not fully seated against the engine block, the oil pump shaft is not engaging the distributor shaft. You may have to turn the rotor

slightly to engage the shaft. Or, hold down on the distributor body and rotate the engine until the distributor drops into position.

STEP 6 If you have to crank the engine, realign the timing marks. Start over again, following Steps 1-5.

STEP 7 Install the distributor hold-down clamp and hold-down bolt, but do not tighten them.

STEP 8 Rotate the distributor body until the contact points just start to open.

STEP 9 Hold the distributor cap in place above the distributor and make sure that the rotor tip lines up with the #1 spark plug terminal.

STEP 10 Tighten the distributor hold-down bolt and complete the rest of the distributor installation procedure. Reinstall the spark plug.

Turn to your Review Exercise Book and complete Exercise 11.

WORK ACTIVITY

Do not begin this work activity until you have your instructor's approval. If you have any difficulty, review the pages listed next to the work activity. If you still have difficulty, ask your instructor for help.

7. Install the distributor in an engine without markings, or install the distributor after the engine has been cranked accidentally. (pages 84-85) *Check your work with your instructor.*

When you have finished this activity, ask your instructor to return your pretest on Performance Objective 10. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will then tell you if you are ready to be checked off on the performance checklist or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

PERFORMANCE OBJECTIVE 11

STROBE THE DISTRIBUTOR AND ADJUST THE ADVANCE MECHANISMS

INTRODUCTION TO P.O. 11

In this performance objective, you will learn how to strobe a distributor and adjust timing advance mechanisms. Both of these procedures are done using a distributor tester.

You may find it helpful to review Performance Objective 8, pages 9-18. These pages contain information on visually inspecting contact points and condensers, and on testing these parts. You may also want to review pages 47-69 of Performance Objective 9. There you will find further information on contact point adjustments, ignition timing, and engine idle speed adjustments.

After you have finished all the work activities for Performance Objective 11, your instructor will use a checklist like the one below to evaluate your work.

Performance Checklist—P.O. 11

The instructor will provide a shop distributor and either a live vehicle or a live engine. Strobe the distributor and adjust the advance mechanisms. All of the performances below must be accomplished.

Student Performances

Instructor Ratings

	Acceptable	Not Acceptable	Omit
*1. Removes the distributor from the vehicle.			
2. Mounts the distributor in the tester.			
3. Visually inspects the distributor.			
4. Tests and records the results for the following:			
Condenser			
Contact point resistance			
Contact point spring tension			
Contact point alignment			
Contact point dwell and dwell variation			
Contact point float and bounce			
Cam lobe accuracy			
Shaft, bushings, and breaker plate			
Mechanical advance			
Vacuum advance and retard			
5. Adjusts the mechanical advance.			
6. Adjusts the vacuum advance and retard.			
*7. Installs the distributor.			
8. Uses the proper tools and equipment.			
9. Follows all appropriate safety precautions.			
10. Performs tasks in an acceptable amount of time.			

SAMPLE

*These steps can be omitted if both the distributor and the live engine have been provided.

Tools and Equipment

For this objective, you will need to use the tools and equipment listed below. You will be given the procedures for using special tools and equipment as you work through the activities.

Basic Hand Tool Set

Special Hand Tools

distributor point tool
distributor wrench, as needed
distributor point adjuster
(window-type distributors)

Basic Equipment

fender covers
extension light
timing light
dwell meter
tachometer

Special Equipment

distributor tester
distributor puller
power timing light with timing advance meter

Reading List

If you would like additional information as you work through this performance objective, use the references below.

General References

Crouse, ***Automotive Mechanics***, p. 314.

Crouse, ***The Auto Book***, pp. 366-67.

Ellinger, ***Automechanics***, pp. 292-93.

Ellinger, ***Auto Service and Repair***, pp. (21-17)-(21-18).

Toboldt and Johnson, ***Automotive Encyclopedia***, pp. 399-402.

Special-Purpose Reference

Crouse, ***Automotive Electrical Equipment***, Ch. 14.

Personal and Service Safety Practices

Safety When Working around a Distributor Tester

Rotor. Always remove the rotor before testing the distributor. An unguarded rotor turning at high speeds on the tester can cause damage or personal injury.

Eye protection. Always wear eye protection when using a distributor tester. Flying dirt or chips can get into your eyes.

Drive gear. Do not allow the distributor drive gear or shaft to rest in the bottom of the tester chuck. This can cause damage to the tester or distributor shaft to have runout.

Adapters. Always use the proper adapters when mounting a distributor in a tester. Using the wrong size or type adapter can cause damage to the distributor.

Clean distributor. Always wash and clean the body of the distributor before mounting it on the distributor tester. Dirt can foul the tester and cause it to work incorrectly.

Safety When Working around an Operating Engine

Fender covers. Always use fender covers when you are working under the hood. This will keep the fenders from getting scratched.

Clean area. Always wipe the distributor cap and surrounding area before removing the cap. This will help keep dirt from getting inside the distributor.

Personal safety. Do not reach into the engine compartment without looking first. Your fingers can get caught by moving parts when the engine is cranking or operating.

When cleaning the timing marks, DO NOT crank the engine while your hands or a loose cloth are near the engine fan blades or lower pulley. Injury can result.

When using the timing light, do not hit the engine fan blades. You can damage the timing light.

Safety When Making an Electrical Test

Correct procedures. Always follow the electrical test equipment manufacturer's procedures. This includes procedures for the proper care and use of the equipment as well as instructions for making important equipment calibrations.

Personal safety. Never do an electrical test while standing on a wet floor or when engine parts are wet. A painful shock can result.

Safety in Work Clothing and Grooming

Metal. Avoid wearing any metal (rings, buckles, wristwatches, necklaces) that might come in contact with an electrical part. You can receive a severe burn.

Clothing. Avoid wearing loose clothing or anything that can hand down and get caught by moving parts. Injury can result.

Hair. Keep long hair from hanging down near moving parts. Keep your hair under a hat if it is longer than standard length.

USING A DISTRIBUTOR TESTER

In Performance Objective 10 you learned how to remove the distributor from the engine and how to install it. In this performance objective you will learn how to use a distributor tester (see Figure 11-1). Also, you will learn how to do certain distributor tests and how to adjust the distributor while it is on the tester.

Purpose and Operation of the Distributor Tester

The distributor tester (see Figure 11-1) is used to accurately test and adjust the distributor outside the vehicle engine.

Figure 11-1 Distributor tester

Adapted from *Performance Provers from Sun. A Complete Line of Automotive Tune-Up and Service Equipment.* Used with permission of Sun Electric Corporation.

The distributor tester is also called a synchroscope (sin cro scope). The distributor is mounted on the tester. Then, the distributor shaft and distributor cam are rotated at different speeds, just as they are when operating in an engine. In addition, the distributor tester tests the condenser, points, and mechanical parts, and measures the timing advance curves and compares them to the vehicle manufacturer's specifications.

For the best tune-up results, a distributor should be tested and adjusted on a distributor tester. The ***timing advance curve adjustments*** must be done on the tester because of the high degree of accuracy they require.

Mounting the Distributor

Mounting the distributor properly is important if test results are to be accurate. Always follow the tester manufacturer's operation procedures. Procedures should follow these general steps:

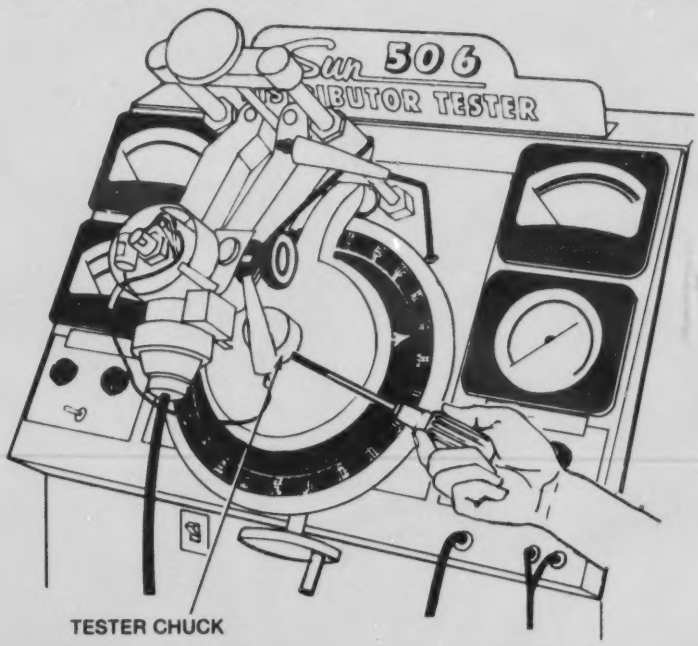
STEP 1 Wash the body of the distributor. (A dirty distributor will get the distributor tester dirty and may cause it to work incorrectly.)

STEP 2 Raise the arms of the tester clamps. This way, when the distributor is installed in the arms, the distributor will not contact the tester chuck. The chuck is the part that grips the distributor drive gear or distributor shaft, as shown in Figure 11-2.

STEP 3 Place the distributor in the clamp arms. Make sure the vacuum advance chamberpoints to your right.

STEP 4 Tighten the clamps so that they secure snugly in the clamp arms.

Figure 11-2 Chuck on distributor tester



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NOTE: Always clamp the largest part of the distributor body. Use tester adapters if they are needed to avoid damaging the distributor body. Special adapters will also keep the distributor in proper alignment with the chuck of the tester.

STEP 5 Before lowering the distributor into the chuck of the tester, move the distributor shaft up and down with your hand.

- Check the distribution shaft for end play.
- Check the vehicle manufacturer's specifications to find out how much end play is allowed. If there is too much end play, the distributor shaft thrust washers should be replaced or the distributor should be replaced.

CAUTION: Do not check shaft end play by pulling up on the cam assembly.

STEP 6 Rotate the distributor shaft by hand and check for binding or dragging (turning that is not smooth).

If there is binding or dragging, the distributor shaft may be bent and will have to be replaced or the whole distributor may have to be replaced.

STEP 7 Lower the distributor until drive gear or shaft is in the chuck of the tester.

- Do not allow the distributor drive gear or shaft to rest in the bottom of the tester chuck. This causes the distributor shaft to bind and also causes damage to the tester.
- Use rubber tubing if necessary to protect the gear teeth. The rubber tubing will prevent marking and possibly damaging the gear teeth.
- Use drive gear adapters if necessary to protect the gear teeth.

STEP 8 Tighten the chuck and then tighten the tester clamp arms.

STEP 9 Turn the distributor shaft by hand and check to see that it is free and ***not binding or dragging.*** If it is binding, loosen the clamp arms and center the distributor. Align it with the chuck of the tester.

STEP 10 Remove the rotor. An unprotected rotor turning at high speeds can cause damage and personal injury.

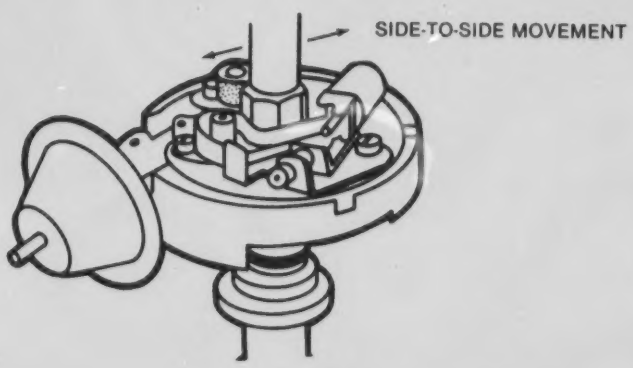
DEFECTS THAT MAY DEVELOP IN THE DISTRIBUTOR (VISUAL CHECKS)

After mounting the distributor, look for visible defects.

Distributor Shaft

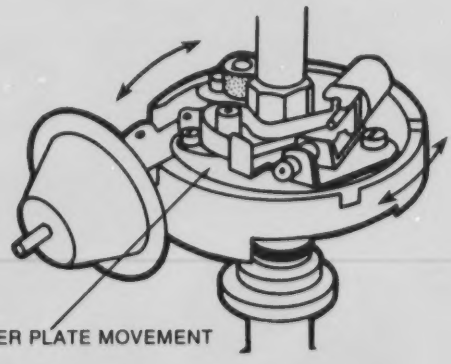
First, check the shaft for side play (see Figure 11-3).

Figure 11-3 Checking distributor shaft side play



To do this, move the distributor shaft from side to side with your hand. Then, check the vehicle manufacturer's specifications to find out how much side play is allowed. If there is too much play in the shaft, the distributor may have to be replaced.

Figure 11-4 Checking the breaker plate for proper movement



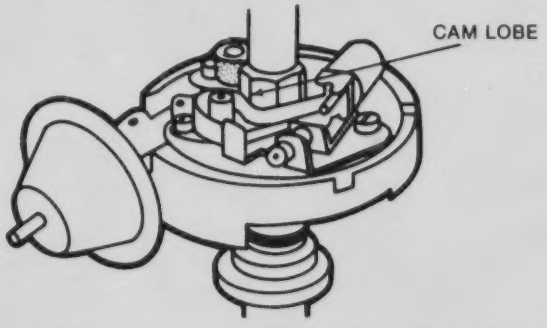
Rotate the breaker plate back and forth and check for smoothness or binding, as shown in Figure 11-4. The breaker plate must move freely in order to operate properly. Also,

check the breaker plate for wobble and/or looseness. A binding or wobbling breaker plate assembly affects timing advance and may cause contact point dwell to change.

Cam Lobes

Visually check the cam lobes for signs of extreme wear. If the lobes are dry and shiny, and show particles of the contact point rubbing block, further tests are required. If the lobes are worn, the distributor cam should be replaced. Lubricate the cam lobes *only* with special cam lubricant. You will learn more about checking cam lobes in Performance Objective 12.

Figure 11-5 Checking cam lobes for wear



Lubrication

Check the distributor for proper lubrication. Look at the distributor shaft, cam lobes, and breaker plate assembly. If the parts are dry, there is not enough lubrication. This causes rapid wear of the parts. However, too much lubrication may spatter on the contact points and cause them to burn or cause point resistance problems.

Electrical Leads

Check the condenser, coil, and ground leads for worn, frayed, or oil-soaked insulation. These defects could cause a short in the ignition circuit. Also, check for loose electrical connections.

Contact Points

Check the contact points to see if they are dirty, pitted, or burned. These conditions affect ignition output and mean that the points must be replaced.

Summary of Defects and Corrections

In the following troubleshooting table, you will find various distributor defects, the problems they cause, and ways to correct the defects. You do not need to make the corrections yet. But you should know how to recognize the defects and know how to correct the defects.

Table 11-1 Distributor Defects and Corrections

DEFECT	WILL CAUSE	CORRECTION
Too much side play of distributor shaft OR Distributor shaft binds when rotated	Changes in contact point dwell AND Changes in ignition timing	Replace the shaft and bushings. Replace the distributor housing if necessary.
Binding or looseness of breaker plate	Incorrect timing advance Change in contact point dwell	Replace the breaker plate assembly and/or the nylon guides.
Cam lobe wear	Change in contact point dwell	Replace the cam.
Lack of lubrication	Rapid wear of the shaft and bushings Rapid wear of the rubbing block and cam	Lubricate at the oilers. Lubricate the cam with cam lubricant.
Too much lubrication	Burning of contact points	Replace the distributor seal and/or clean the breaker plate assembly and cam.
Defective electrical leads	Ignition *short,* or open circuit	Replace the condenser and/or coil lead. Tighten the connections.
Dirty, pitted, or burned points	Engine missing, skipping, or hard to start	Replace the contact points.

Turn to your Review Exercise Book and complete Exercise 12.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

1. Mount a distributor on a distributor tester. (pages 94-95)

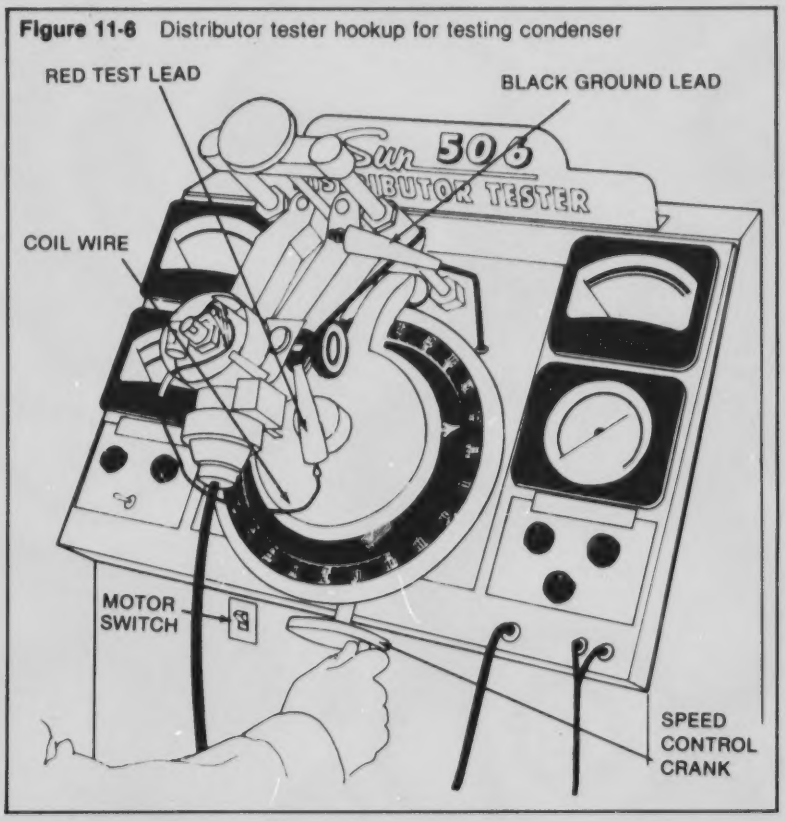
2. Inspect a distributor for defects. List the defects you find. (pages 96-98) *Check your work with your instructor.*

After you have finished these activities, go on to the next section.

CONDENSER, CONTACT POINTS, AND DISTRIBUTOR MECHANICAL TESTS

The following tests or testing procedures all use a distributor tester. The basic tests that you have learned in other performance objectives will not be repeated.

Figure 11-6 Distributor tester hookup for testing condenser



Adapted from *Performance Provers from Sun. A Complete Line of Automotive Tune-Up and Service Equipment.* Used with permission of Sun Electric Corporation.

Testing the Condenser

STEP 1 Plug the distributor tester electrical power lead into a wall outlet. Turn the ***motor*** switch of the tester to the proper shaft rotation (***left-hand drive*** or ***right-hand drive***). This switch also turns on the power for the distributor tester (see Figure 11-6).

STEP 2 Rotate the distributor shaft by hand until the contact points are open.

STEP 3 Connect the red test lead to the distributor terminal or coil wire. Connect the black lead to the tester's ground stud.

STEP 4 Test for condenser series resistance, leakage, and capacity. To review these tests, refer to Performance Objective 9.

Testing the Contact Points

To test the contact points, you must use the distributor tester's drive unit, a tachometer, and a dwell meter.

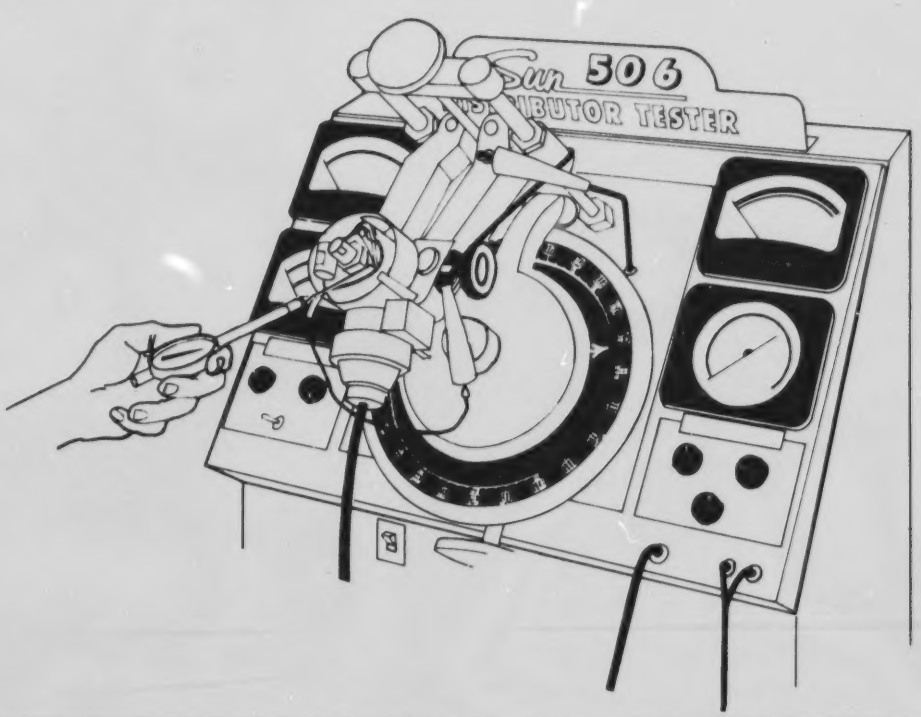
The drive unit is the part of the tester that turns the distributor shaft. It is controlled by a two-position motor switch. This switch controls the power for the tester, and controls the drive unit's direction of rotation.

The tachometer is powered internally by the drive unit and needs no external connections.

The dwell meter uses the same red and black test leads as the condenser tester.

A ***speed control crank*** controls the speed of distributor shaft rotation. It allows you to vary the RPM of the shaft to meet certain test specifications.

Figure 11-7 Testing contact point spring tension



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Contact point spring tension. To test the contact points spring tension, using a dwell meter and tension gauge:

STEP 1 Turn the distributor shaft until the points are closed.

STEP 2 Hook the spring tension gauge over the movable contact point, as shown in Figure 11-7.

STEP 3 Pull the gauge straight out and away from the contact point. Record the reading of the spring tension gauge when the dwell meter starts to fall to zero degrees (0°).

STEP 4 For adjusting procedures, refer to Performance Objective 9.

Contact point alignment.

STEP 1 Visually inspect the contact points to see if they are in proper alignment.

STEP 2 Turn the speed control crank so that the distributor shaft operates at approximately 1,000 RPM.

STEP 3 View the contact points from above and from the side. A small spark should be visible near or at the center of the contact points. For adjusting procedures, refer to Performance Objective 9.

Contact point resistance. For testing procedures, refer to Performance Objective 9.

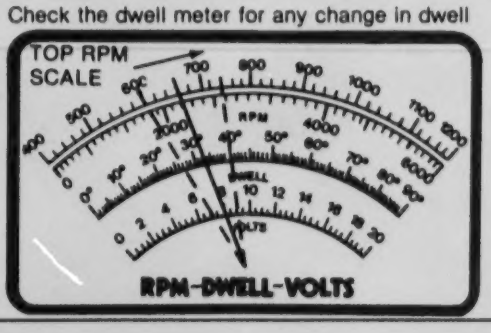
Contact point dwell.

STEP 1 Turn the speed control crank until the distributor shaft is operating at 300 RPM.

STEP 2 For dwell testing and point gap adjusting procedures, refer to Performance Objective 9.

Dwell variation. This test is to find out if there is a gradual change in dwell as the engine speed increases. If the dwell does change, look for a worn distributor shaft and worn bushings, a bent distributor shaft, or a loose breaker plate.

Figure 11-8 Check the dwell meter for any change in dwell



To test for dwell variation:

STEP 1 Increase the distributor shaft speed *slowly* up to 2,500 RPM.

STEP 2 Watch the dwell meter for any change in dwell.

STEP 3 Record your results and compare them with the vehicle manufacturer's specifications for dwell variation.

Contact point float.

STEP 1 Increase the distributor shaft speed quickly to 2,500 RPM.

STEP 2 Watch the dwell meter for a sudden change in dwell.

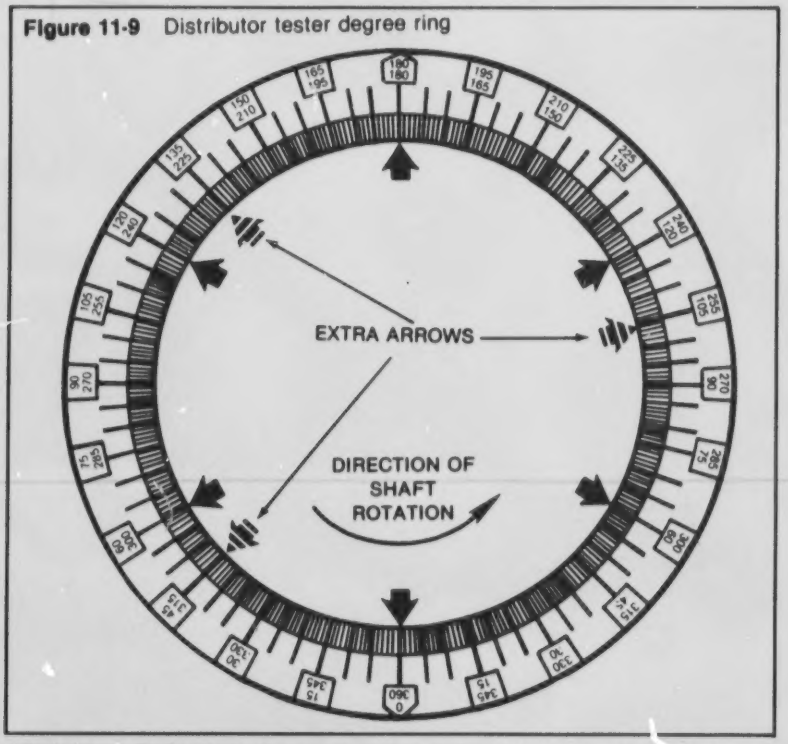
A sudden change in dwell indicates that the contact points *floated.* That is, they remained open for a part of the dwell period. Low contact point spring tension or a narrow point gap (high dwell reading) may be the cause.

Contact point bounce.

STEP 1 Increase the distributor shaft speed to 2,500 RPM.

STEP 2 Watch the flashing arrows on the tester degree ring.

Figure 11-9 Distributor tester degree ring



Adapted from *Performance Provers from Sun. A Complete Line of Automotive Tune-Up and Service Equipment.* Used with permission of Sun Electric Corporation.

On the distributor tester degree ring (see Figure 11-9) there should be a flashing arrow for each cam lobe (8 arrows for 8-lobe cams, 6 arrows for 6-lobe cams, 4 arrows for 4-lobe cams).

If any additional arrows appear, this means that the contact points are bouncing open and then closing. This is caused by high contact point spring tension or binding in the contact point pivot post. This indicates that the contact points should be replaced, or that the spring tension should be adjusted to the manufacturer's specifications.

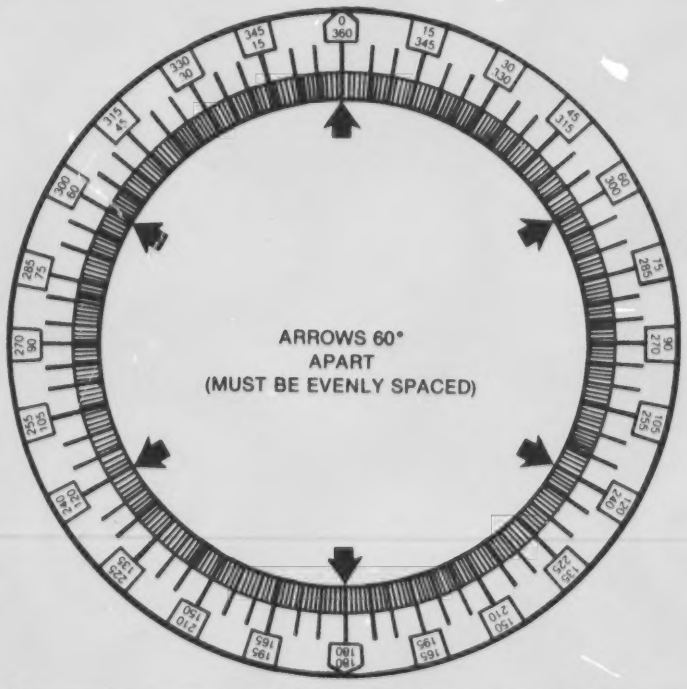
Cam lobe accuracy. This test checks cam lobe condition. Cam lobes should be a specified number of degrees apart.

To check cam lobe condition:

STEP 1 Operate the distributor shaft at 1,000 RPM.

STEP 2 Rotate the degree ring by hand until the zero point is aligned with any one of the flashing arrows, as shown in Figure 11-10.

Figure 11-10 Zero point is lined up with one arrow.



Adapted from ***Performance Provers from Sun. A Complete Line of Automotive Tune-Up and Service Equipment.*** Used with permission of Sun Electric Corporation.

STEP 3 Look at each of the other flashing arrows on the degree ring.

The arrow flashes should be evenly spaced around the degree ring (45 degrees apart for 8-lobe cams, 60 degrees apart for 6-lobe cams, 90 degrees apart for 4-lobe cams).

The arrows should be spaced evenly around the degree ring within one degree at each lobe point. Arrows that are not within one degree of their correct location indicate a worn cam lobe, a bent distributor shaft, or worn distributor shaft bushings.

Distributor bushing, shaft, and breaker plate condition. This test is made to find out if the distributor shaft, its bushings, or the breaker plate has excessive play *during* operation.

STEP 1 Vary the distributor shaft speed from 300 to 2,500 RPM.

STEP 2 Visually inspect the distributor shaft and breaker plate for runout or wobble. Any wobble or too much runout affects ignition operation.

Summary of Distributor Tests

The following table summarizes the distributor tests you have learned.

Table 11-2 Distributor Tests

TEST	TEST INSTRUMENT	CONDITIONS TESTED
Condenser	Condenser tester	Condenser malfunction
Contact point spring tension	Dwell meter, spring tension gauge	Spring tension adjustment
Contact point alignment	Visual	Alignment adjustment
Contact point resistance	Dwell meter	Contact points
Contact point dwell (300 RPM)	Dwell meter	Gap adjustment
Contact point dwell variation (increase speed slowly to 2,500 RPM)	Dwell meter	Worn distributor shaft and bushings OR Bent distributor shaft OR Loose breaker plate
Contact point float (increase speed quickly to 2,500 RPM)	Dwell meter	Point spring tension OR Point adjustment
Contact point bounce (2,500 RPM)	Degree ring	Too much point spring tension OR Binding in point pivot post
Cam lobe accuracy (1,000 RPM)	Degree ring	Worn cam lobe OR Bent distributor shaft OR Worn distributor shaft and bushings
Distributor bushing, shaft, and breaker plate condition	Visual	Worn distributor shaft and bushings OR Binding or wobbling breaker plate

Turn to your Review Exercise Book and complete Exercise 13

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

3. Test the condenser. Record your results and compare them with manufacturer's specifications. (pages 100-101)

4. Test contact point resistance. Record your results. (page 101)

5. Test contact point spring tension. Record your results and compare them with manufacturer's specifications. (page 102)

6. Test contact point alignment. (page 102) *Check your work with your instructor.*

7. Test contact point dwell and dwell variation. Record your results and compare them with manufacturer's specifications. (pages 102-103)

8. Test for contact point float. (page 103)

9. Test for contact point bounce. (pages 103-104)

10. Test the cam lobe accuracy. Record your results. (pages 104-105)

11. Test the condition of the distributor bushing, shaft, and breaker plate. (page 105) *Check your work with your instructor. structor.*

After you have finished these activities, go on to the next section.

DISTRIBUTOR MECHANICAL ADVANCE

The main function of the distributor is to deliver the spark to the spark plugs at exactly the right time. The ***right time*** is the moment at which the air/fuel mixture is ignited in the cylinder.

You have already learned how to adjust initial timing by adjusting the distributor at engine idle speed (approximately 600 RPM). However, the distributor must also deliver the spark at other engine speeds. As the engine speed increases, the spark needs to ***advance,*** or move ahead. As the engine speed decreases, the spark needs to ***retard,*** or move back. This spark timing is controlled by a ***mechanical advance mechanism*** in the distributor. It is also called ***centrifugal advance.***

Figure 11-11 Major components of mechanical advance mechanism

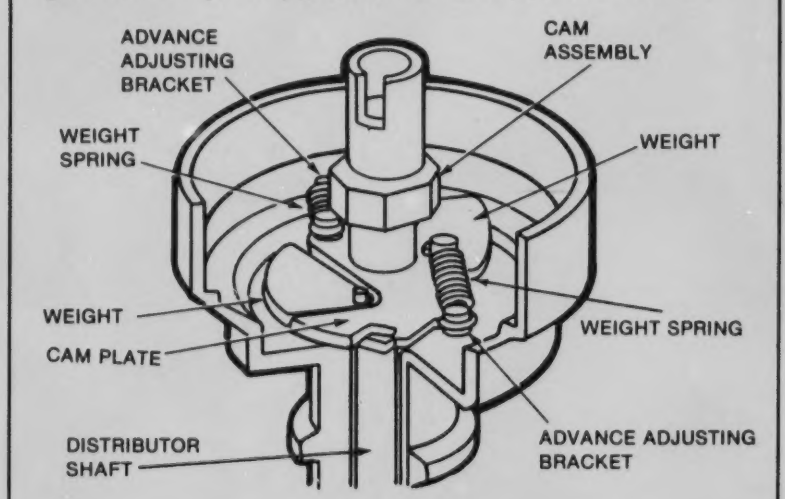
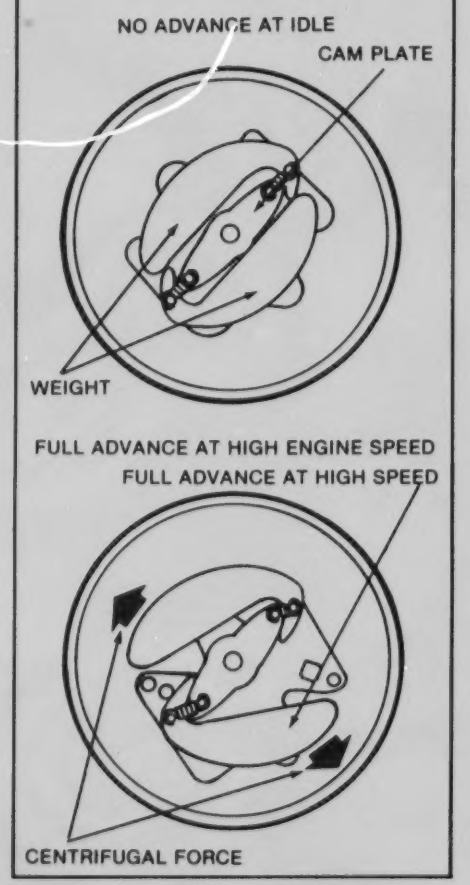


Figure 11-12 Dotted line indicates full advance

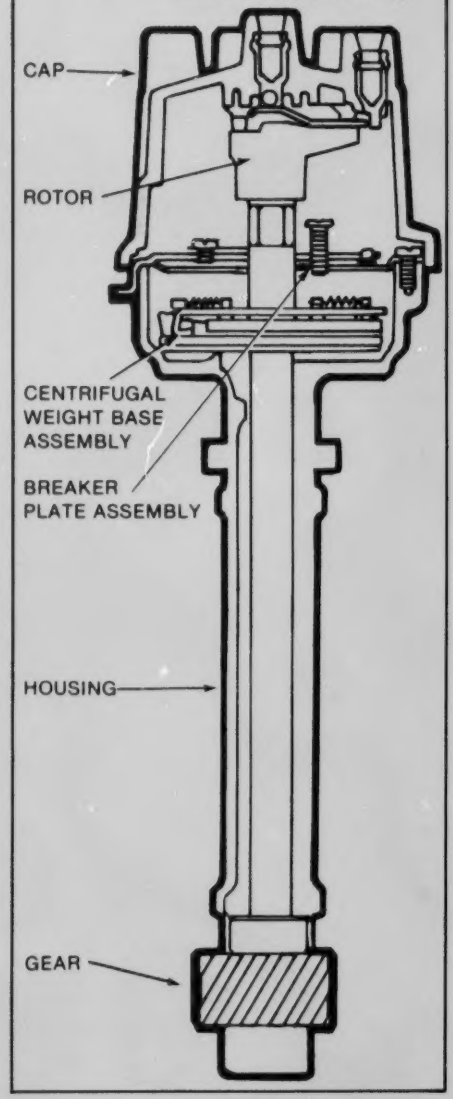


Purpose and Operation of the Mechanical Advance

The mechanical advance mechanism controls spark advance in direct proportion to engine speed. It consists of two weights mounted on the cam plate that is on the distributor shaft, as shown in Figure 11-11. A control spring connects each weight with an adjusting tab or bracket. The springs control the movement of the weights as the engine speed changes.

As the engine speed increases, the centrifugal force, or outward movement, caused by the distributor shaft rotation causes the weights to be thrown outward, as shown in Figure 11-12. Because of this motion, the weights move against the cam plate. The distributor cam is attached to the

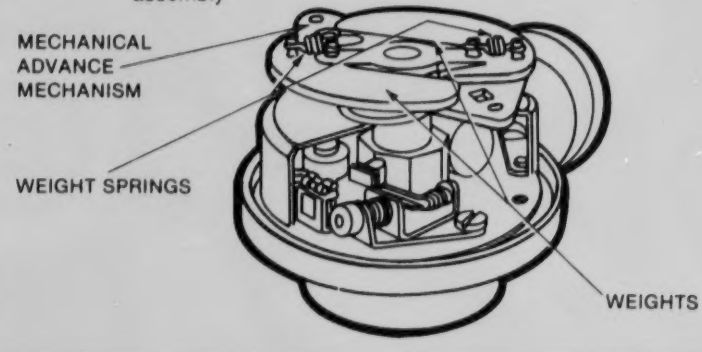
Figure 11-13 Mechanical advance mechanism is under breaker plate assembly



cam plate. As the cam plate turns, the distributor cam rotates ahead of distributor shaft rotation. This causes the distributor cam lobes to open and close the contact points earlier, which advances the spark.

Mechanical advance mechanisms are found in one of two locations, depending on the make of the distributor. On one type of distributor, the weights and springs are found underneath the breaker plate assembly, as shown in Figure 11-13. On another type, the weights and springs are found above the breaker plate assembly, as shown in Figure 11-14.

Figure 11-14 Mechanical advance mechanism is above breaker plate assembly



Testing Mechanical Advance

This test checks to see if the mechanical advance system is causing the spark to advance (or retard) properly at all engine speeds.

To test the mechanical advance system:

STEP 1 Look up the mechanical advance specifications of the vehicle manufacturer and write them down. They will appear in a chart that looks like the one in Figure 11-15.

Figure 11-15 Mechanical advance specifications in a service manual

DISTRIBUTOR MODEL		CENTRIFUGAL ADVANCE					
Standard	Uni-Set	Start		Intermediate		Maximum	
		Deg.	RPM	Deg.	RPM	Deg.	RPM
1112205	1112243	0°	600	5°	850	11°	2300
1112807	1112513	0°	575	4.5°	850	9°	1950
1112804	1112234	0°	600	6.5°	1065	12°	1790

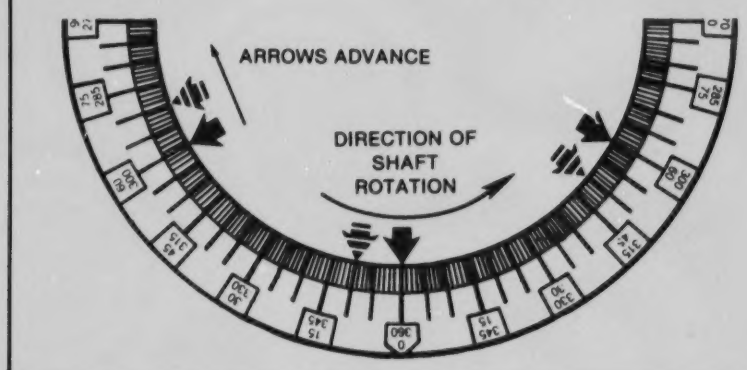
STEP 2 Set the distributor shaft speed at approximately 600 RPM or at the specified ***start*** speed.

STEP 3 Adjust the degree ring of the tester by hand to zero degrees (0°) at any flashing arrow.

STEP 4 Increase the distributor speed to the first specified test speed. Record the new position (in degrees) of the arrow on the degree ring, as shown in Figure 11-16).

For example, following the chart the distributor shaft speed is increased to 850 RPM. The timing advance should read 5°.

Figure 11-16 Dotted arrows indicate new positions



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STEP 5 Increase the distributor speed to each of the other specified speeds. Record the change (in degrees) of the arrow's position.

For example, according to the chart, if the distributor shaft speed is increased to 2,300 RPM, the timing advance should read 11 degrees.

STEP 6 Reduce the distributor speed to the original speed.

The test results are ***good*** if the arrow advanced the specified amount at each of the test speeds, and if the arrow returned to its starting point when the distributor's speed returned to its starting RPM.

Otherwise, the distributor needs to be serviced, adjusted, or replaced. (Sometimes the mechanical advance mechanism is just gummy and sticky, and needs to be cleaned and lubricated.)

Adjusting Mechanical Advance

All distributor mechanical advance mechanisms can be serviced. If the advance is incorrect at low speeds, but

correct at high speeds, look for wear, binding, and dirt in the mechanical advance mechanism.

If advance is too much or too little at all speeds, look for incorrect springs and weights (see Figure 11-17).

Figure 11-17 Weight springs

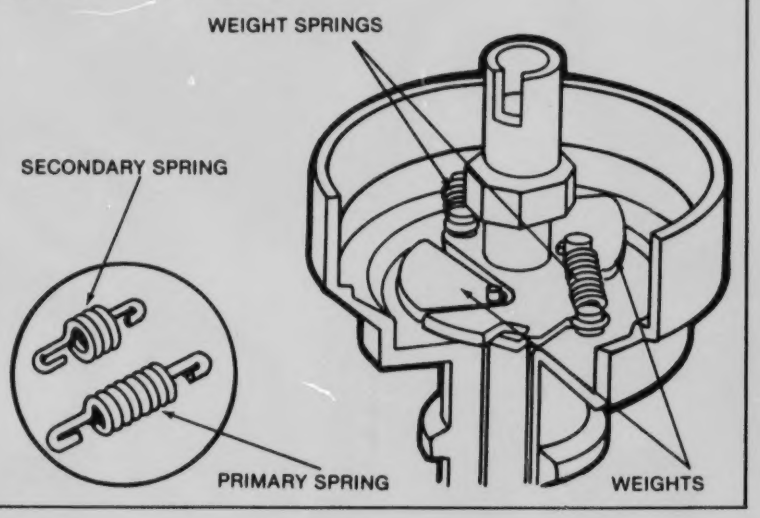


Figure 11-18 Using screwdriver to adjust weight spring adjusting tab

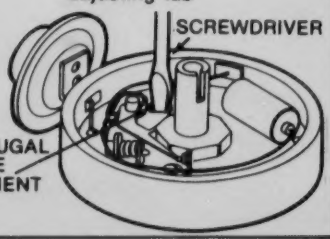
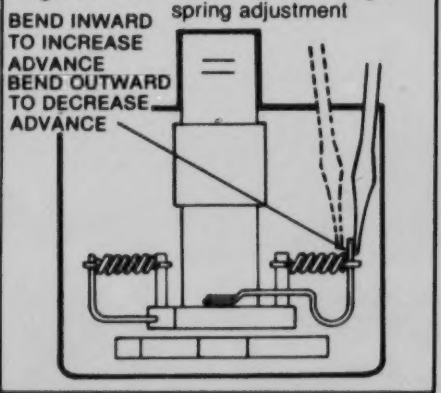


Figure 11-19 Internal view of weight spring adjustment



On some distributor mechanical advance mechanisms, the tension of the two weight springs is adjustable.

The primary spring (low tension) controls the spark advance at lower engine speeds. This spring is usually identified by the greater number of coils and their smaller diameter size.

The secondary spring (high tension) controls the spark advance at higher engine speeds. It prevents ***over-advance*** of the spark. This spring is usually identified by its small number of coils and their larger diameter size.

On one model distributor, the weight spring adjusting tab or bracket is adjusted through a hole in the breaker plate assembly (see Figure 11-18). To adjust the mechanical advance, use a screwdriver and bend the bracket inward (increasing advance) or outward (decreasing advance). (See Figure 11-19.)

On another model distributor, a special tool is used to turn the adjusting posts, as shown in Figure 11-20. Changing the position of the posts increases or decreases the spring tension.

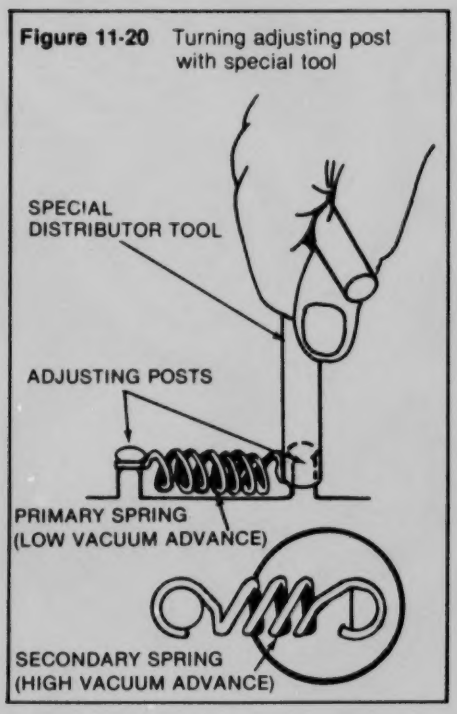


Figure 11-20 Turning adjusting post with special tool

To adjust spring tension:

STEP 1 Release the tension of both springs.

STEP 2 Adjust the primary spring first for low advance settings.

STEP 3 Adjust the secondary spring last for high advance settings.

STEP 4 Recheck the mechanical advance throughout the entire specification range.

NOTE: If it is impossible to adjust both springs to give the correct spark advance throughout the range, one or both springs should be replaced. Be sure to replace the springs with those specified for the distributor.

Turn to your Review Exercise Book and complete Exercise 14.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

12. Test the mechanical advance mechanism of a distributor. Record your results and compare them with the vehicle manufacturer's specifications. (pages 109-110) *Check your work with your instructor.*

13. Adjust the mechanical advance mechanism of a distributor to the vehicle manufacturer's specifications and record your results. (pages 110-112) *Check your work with your instructor.*

After you have finished these activities, go on to the next section.

Figure 11-21 Cutaway view of distributor vacuum advance

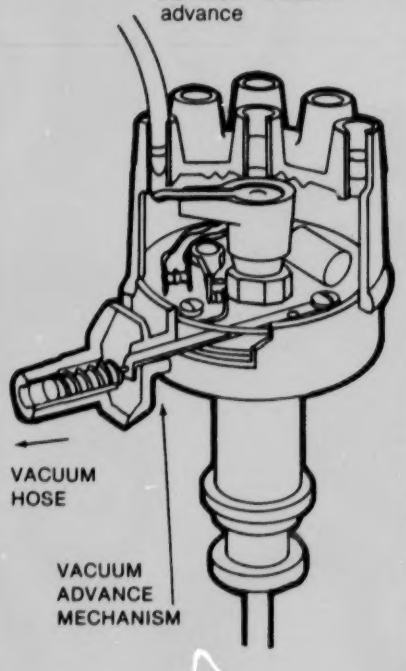
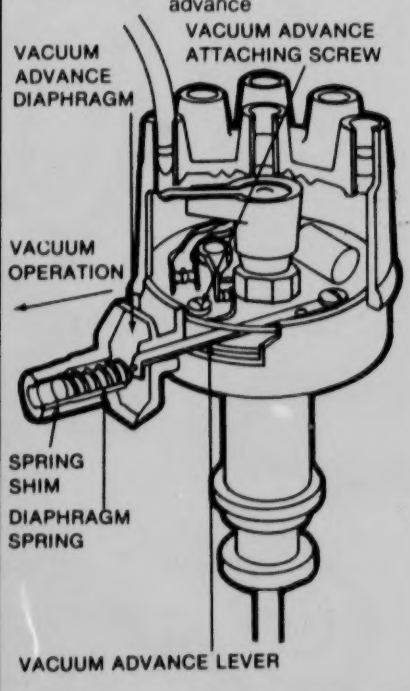


Figure 11-22 Components of vacuum advance



DISTRIBUTOR VACUUM ADVANCE

Purpose and Operation of the Vacuum Advance

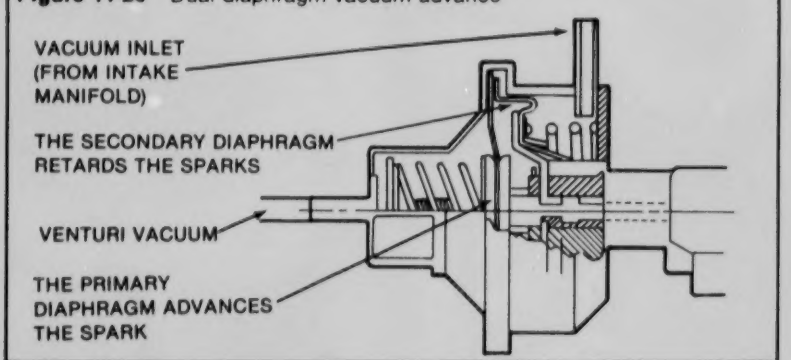
There is another distributor timing advance mechanism, called the ***vacuum advance,*** that you should know how to time and adjust (see Figure 11-21).

Vacuum advance is just as important as mechanical advance in vehicle operation. Vacuum advance controls spark timing at different engine loads. ***Load*** refers to the burning of different amounts of air/fuel mixtures under acceleration, at high speeds, and during deceleration conditions. Timing advance in this case is controlled and operated by the carburetor throttle opening, which controls the vacuum.

The vacuum advance mechanism is attached to the distributor body. It has a vacuum advance lever, which is attached to the distributor breaker plate assembly and to the vacuum advance diaphragm, as shown in Figure 11-22. The vacuum acting on the diaphragm causes the advance lever to move and, in turn, rotates the breaker plate. The breaker plate rotates in the opposite direction of cam rotation. This causes the contact points to open earlier, which advances the spark. Then when the throttle closes, the vacuum diaphragm spring pushes the diaphragm back to its start position. On some advance mechanisms, the primary spring on the breaker plate assembly will pull the breaker plate back and retard the timing. Adjustments can be made by changing the spring shim washers.

On some distributors you will find a ***dual-diaphragm advance-retard mechanism.*** This mechanism has two diaphragms instead of one (see Figure 11-23). The ***primary*** diaphragm advances the spark as on a normal single diaphragm unit. The ***secondary,*** or ***retard,*** diaphragm operates independently of the primary diaphragm and moves the breaker plate to full retard position.

Figure 11-23 Dual diaphragm vacuum advance


VACUUM INLET (FROM INTAKE MANIFOLD)
THE SECONDARY DIAPHRAGM RETARDS THE SPARKS
VENTURI VACUUM
THE PRIMARY DIAPHRAGM ADVANCES THE SPARK

There are other kinds of vacuum advance mechanisms that are even more complicated in design. However, the purpose of all vacuum advance mechanisms is the same: to control the spark timing relative to throttle opening and engine load.

Testing Vacuum Advance

Vacuum chamber leaks. This test is made to find out if the vacuum advance chamber has any leaks in its diaphragm.

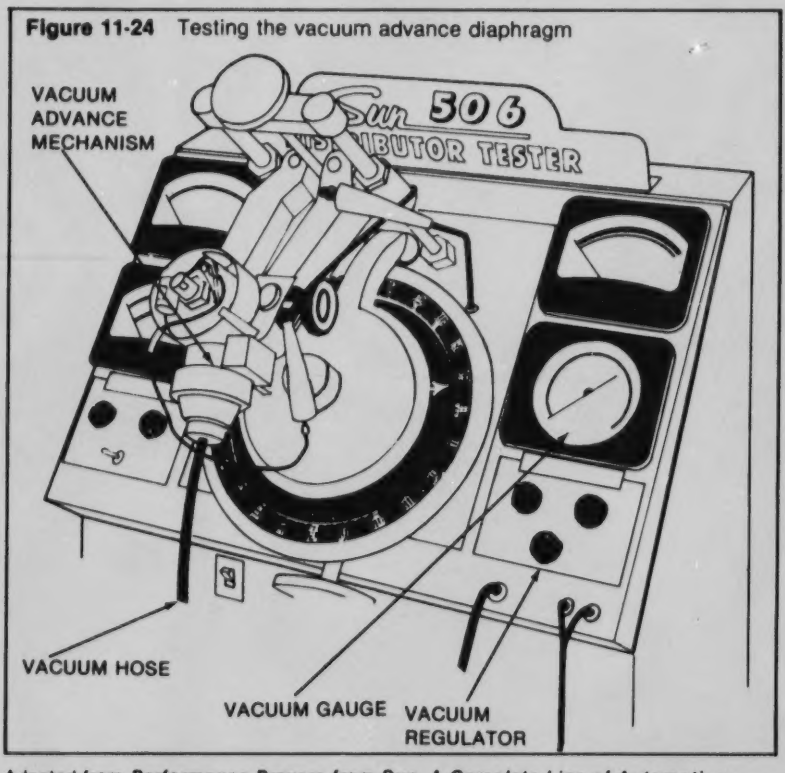
To test for diaphragm leaks:

STEP 1 Turn the distributor shaft speed to zero RPM.

STEP 2 Connect the vacuum hose to the distributor vacuum advance inlet, as shown in Figure 11-24.

STEP 3 Clamp the vacuum hose closed.

Figure 11-24 Testing the vacuum advance diaphragm



Adapted from *Performance Provers from Sun. A Complete Line of Automotive Tune-up and Service Equipment.* Used with permission of Sun Electric Corporation.

STEP 4 Adjust the vacuum regulator until the vacuum gauge reads about 15 inches.

NOTE: Vacuum readings are expressed in inches of mercury, called in. Hg (Hg is the chemical term for Mercury). *In. Hg* tells us the amount of vacuum that a part obtains.

STEP 5 Open the clamp on the vacuum hose. Watch the vacuum gauge.

The reading is ***good*** if it first drops toward zero and then climbs back to the vacuum setting in Step 4 (15 inches).

The reading is ***bad*** if it does not climb back to the setting in Step 4. This shows the diaphragm has a leak, and that the vacuum advance unit should be replaced.

Vacuum plate action. This test is made to find out if there is any binding or wear in the vacuum advance mechanism.

STEP 1 Set distributor speed to approximately 200 RPM.

STEP 2 Vary the vacuum from 0 to 20 inches. Watch the operation of the breaker plate.

Operation is ***good*** if the breaker plate moves smoothly as the vacuum is varied.

Operation is ***bad*** if the breaker plate does not move or if it moves in a series of jerks. This indicates binding or too much wear on the plate or linkage. Try a small amount of lubrication to free any binding. Worn parts should be replaced.

STEP 3 Repeat the vacuum plate action test and watch the dwell meter.

Operation is ***good*** if the breaker plate pivots with less than 2° change in dwell. (Compare your results with the vehicle manufacturer's specifications. Some vehicles allow 5° to 7° change in dwell.)

Operation is ***bad*** if the dwell varies more than the specified amount. Look for worn parts and replace them.

Vacuum advance. This test is made to find out if the vacuum advance changes the timing the correct amount at all specified vacuum levels.

STEP 1 Look up the vacuum advance specifications of the vehicle manufacturer and write them down. They will appear in a chart that looks like one of these examples:

EXAMPLE 1:

DISTRIBUTOR PART NO.	VACUUM ADVANCE (DISTR. Deg. and In. of Hg)			
	Deg.	In. Hg	Deg.	In. Hg
1112807	0°	8-10	10°	16
1112808	0°	4-6	12.5°	11

EXAMPLE 2:

DISTRIBUTOR PART NO.	VACUUM ADVANCE (DISTR. DEGREES)				
	Deg. In.Hg	Deg. In.Hg	Deg. In.Hg	Deg. In.Hg	Deg. In.Hg
C8AF—B	0-1° 5	3-6° 10	6 ½-8° 15	6 ½-9° 20	6 ½-9° 25
C8VF—C	0-¾° 5	½-4° 10	6-9° 15	8 ½-11 ½° 20	9 ½-12° 25

STEP 2 Operate the distributor shaft speed at approximately 200 RPM.

STEP 3 Set the *zero* on the degree ring to any flashing arrow.

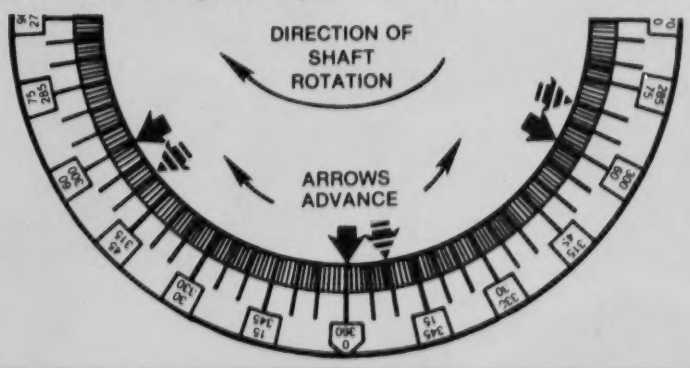
STEP 4 Increase the vacuum. Record when the arrow first starts to move.

STEP 5 Increase the vacuum to the first reading specified by the vehicle manufacturer. Record the new position of the arrow on the degree ring.

For example, according to Example Chart 1, at 8-10 inches of vacuum the timing advance should be at 0°.

STEP 6 Increase the vacuum to each of the specified amounts. Record the new position of the arrow on the degree ring at each vacuum increase (see Figure 11-25).

Figure 11-25 Checking the new position of the arrows



Adapted from ***Performance Provers from Sun. A Complete Line of Automotive Tune-Up and Service Equipment.*** Used with permission of Sun Electric Corporation.

For example, according to Example Chart 1, at 16 inches of vacuum the timing advance should read 10°.

STEP 4 Reduce the vacuum to zero. The arrow should return to zero. If it does not, the mechanism needs to be serviced, replaced, or adjusted.

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Adjusting Vacuum Retard

A vacuum retard test is done only on dual-diaphragm vacuum advance mechanisms. This test is done to find out if the vacuum retard correctly changes the timing at all specified vacuum levels.

The vacuum retard diaphragm is not adjustable. If the timing is incorrect, the vacuum advance mechanism must be replaced.

To test for the vacuum retard:

STEP 1 Look up the vacuum retard specifications of the vehicle manufacturer and write them down.

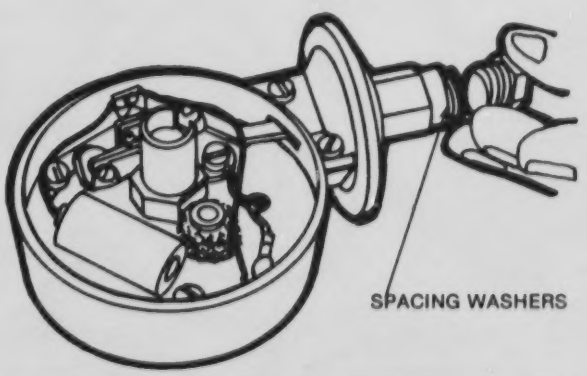
STEP 2 Connect the tester vacuum hose to the vacuum inlet (retard side) of the dual-diaphragm vacuum advance mechanism.

STEP 3 Then, follow the same test procedures as when testing vacuum advance.

Adjusting Vacuum Advance

Most vacuum advance mechanisms are not adjustable. When these mechanisms do not meet manufacturer's operating specifications, they must be replaced. For those vacuum advance mechanisms that are adjustable, changes are made by adjusting the spring tension of the diaphragm spring. On dual-diaphragm advance-retard mechanisms, the ***primary*** spring tension is adjustable, but the ***secondary (retard)*** diaphragm spring tension is not.

Figure 11-26 Adjusting advance mechanism with spacing washers



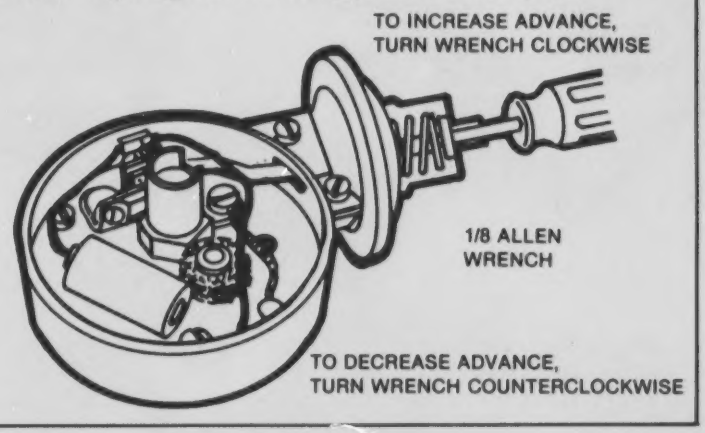
Some advance mechanisms are adjusted by placing spacing washers or spring shim washers between the diaphragm spring and the inlet plug, as shown in Figure 11-26.

To ***increase*** vacuum advance, remove washers. Remove one washer at a time; then recheck vacuum advance.

To *decrease* vacuum advance, add washers. Add one washer at a time; then recheck vacuum advance.

Some vacuum advance mechanisms are adjusted by an allen wrench. Remove the inlet plug and insert the allen wrench, as shown in Figure 11-27.

Figure 11-27 Adjusting a vacuum advance with an allen wrench



To *increase* vacuum advance, turn the allen wrench clockwise.

To *decrease* vacuum advance, turn the allen wrench counterclockwise.

Review of Timing Devices

Timing devices deliver the spark to the spark plugs at the right moment for proper combustion.

Initial Timing: timing set at specific engine idle speeds.

Mechanical Advance: regulates timing advance with changes in engine speed.

Vacuum Advance: regulates timing advance with changes in engine load.

Turn to your Review Exercise Book and complete Exercise 15.

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WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

14. Test the vacuum advance mechanism of a distributor. Record your results and compare them with the vehicle manufacturer's specifications. (pages 114-117) *Check your work with your instructor.*

15. Test the vacuum retard of a dual-diaphragm vacuum advance mechanism. Record your results and compare them with the vehicle manufacturer's specifications. (pages 113-114) *Check your work with your instructor.*

16. Adjust the vacuum advance mechanism of a distributor to the vehicle manufacturer's specifications. (pages 117-118) *Check your work with your instructor.*

After you have finished these activities, go on to the next section.

DISTRIBUTOR TESTING PROCEDURES (WITH DISTRIBUTOR IN VEHICLE ENGINE)

Before testing the distributor in the vehicle engine, be sure to follow the safety practices listed in the introduction to this performance objective.

Visual Checks

Refer to pages 96-99 of this performance objective for defects that may develop in the distributor.

Condenser, Contact Points, and Mechanical Parts

Refer to pages 100-119 of this performance objective for testing procedures.

Engine RPM

Adjust engine idle rpm to manufacturer's specifications. Refer to the use of the dwell tachometer in Performance Objective 9.

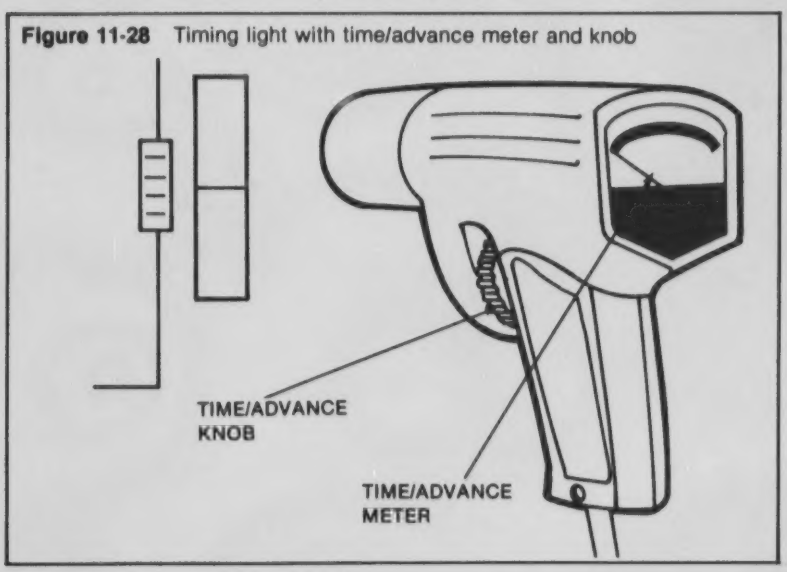
Ignition Timing

Adjust initial or basic timing to manufacturer's timing specifications. For initial timing adjusting procedures, refer to Performance Objective 9.

Mechanical Advance

This test is made with the distributor in the engine to find out if the advance mechanism is working properly. The test is done using a tachometer and a special power timing light.

Figure 11-28 Timing light with time/advance meter and knob



CAUTION: Checking advance mechanisms with a tachometer and timing light gives you only approximate information. The readings you will get will not be exact. Do not try to modify the advance timing with the distributor in the engine. Incorrect spark advance could permanently damage the engine.

To test operation of mechanical advance once the initial ignition timing has been set to manufacturer's specifications:

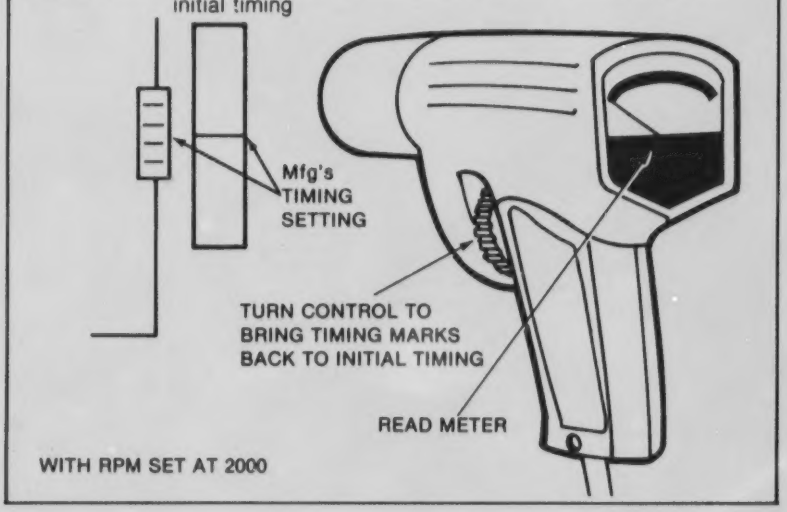
STEP 1 Disconnect the vacuum advance hose(s). Plug the hose(s) with masking tape.

STEP 2 Set the ***time/advance*** knob of the timing light on ***time.***

STEP 3 Operate the engine at the speed specified by the engine manufacturer.

STEP 4 Turn the ***time/advance*** knob until the timing mark moves back to the ***initial*** timing marks, as shown in Figure 11-29.

Figure 11-29 Turning time/advance knob until timing mark returns to initial timing



STEP 5 Note the meter reading, record the advance results, and compare them with the vehicle manufacturer's specifications.

If the timing advances, the advance mechanism is okay.

If the meter reading is not within specifications, the mechanical advance mechanism needs servicing.

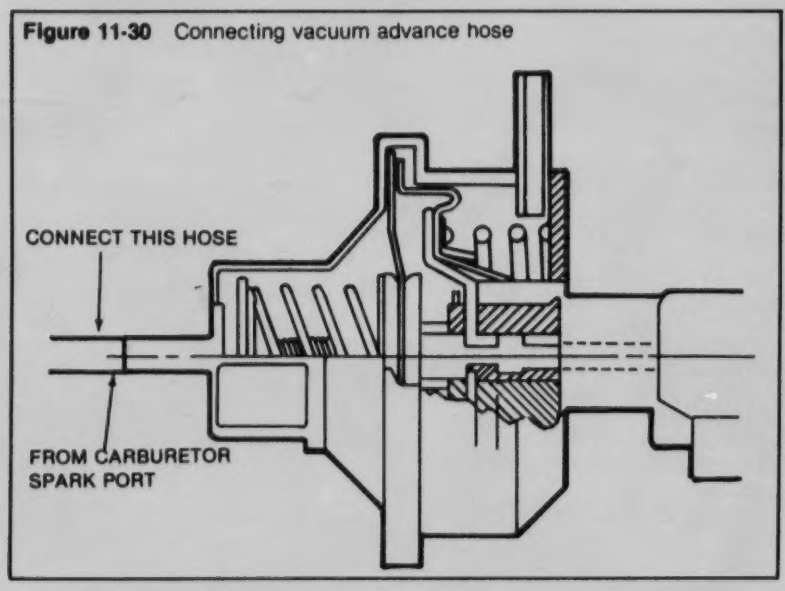
Vacuum Advance

To test the vacuum advance:

STEP 1 Connect the vacuum advance hose(s), as shown in Figure 11-30.

STEP 2 Repeat the same procedures as for testing mechanical advance.

Figure 11-30 Connecting vacuum advance hose



NOTE: Timing should advance *sooner* than with mechanical advance. Also, the advance should be further ahead at the RPM used to check the mechanical advance.

If the timing advances, the diaphragm and the vacuum advance mechanism are okay.

If there is no advance, there is trouble in the vacuum system such as a leaky diaphragm or a sticky advance mechanism.

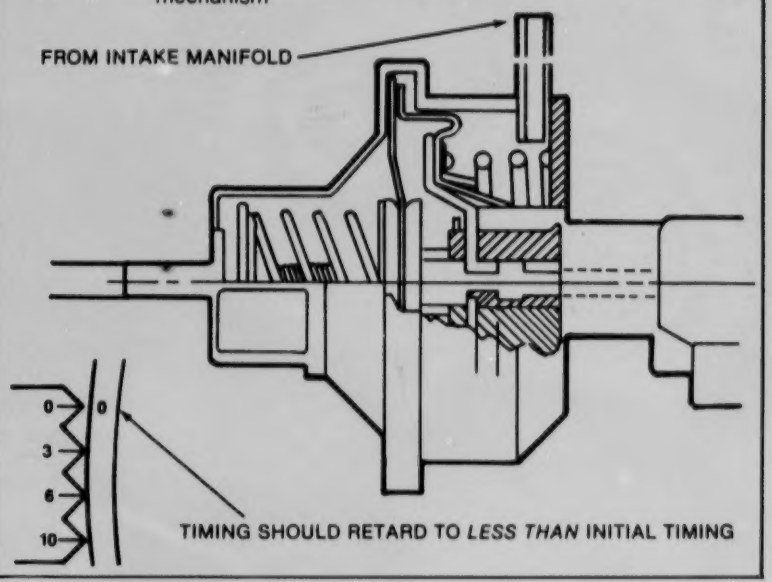
Vacuum Retard Test

A vacuum retard test can also be done with the distributor in the engine.

STEP 1 Connect the vacuum hose from the intake manifold to the retard side of the vacuum advance mechanism, as shown in Figure 11-31.

STEP 2 Check the timing at engine idle speed. The timing should retard to less than that of initial timing.

Figure 11-31 Connecting vacuum hose to retard side of vacuum advance mechanism



If timing retards, the diaphragm and mechanism are okay.

If the timing stays advanced, there is trouble in the vacuum supply or there is a leaky retard diaphragm.

Turn to your Review Exercise Book and complete Exercise 16.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

17. Test the distributor mechanical advance with the distributor in the vehicle engine. Record your readings and compare them with the vehicle manufacturer's specifications. (pages 120-121) *Check your work with your instructor.*

18. Test the distributor vacuum advance with the distributor in the vehicle engine. Record your readings and compare them with the vehicle manufacturer's specifications. (page 122) *Check your work with your instructor.*

19. Test the distributor vacuum retard with the distributor in the vehicle engine. Record the results. (pages 122-123) *Check your work with your instructor.*

When you have finished these activities, ask your instructor to return your pretest on Performance Objective 11. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will then tell you if you are ready to be checked off on the performance checklist or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

PERFORMANCE OBJECTIVE 12

OVERHAUL AND CALIBRATE THE DISTRIBUTOR

INTRODUCTION TO P.O. 12

In this performance objective, you will learn how to calibrate and overhaul a distributor. However, you will learn only the overhaul procedures that are commonly made in a shop. Complete overhaul procedures such as replacing the distributor shaft bushings are normally done only in automotive service centers. Such procedures require special equipment. Also, it is usually cheaper to buy a rebuilt distributor than it is to rebuild one.

You may find it helpful to review Performance Objective 11. There you will find information on visually inspecting distributors and on testing and adjusting distributor timing advance mechanisms.

After you have finished all the work activities for Performance Objective 12, your instructor will use a checklist like the one below to evaluate your work.

Performance Checklist—P.O. 12

The instructor will provide a distributor. Overhaul the distributor. All of the performances below must be accomplished.

Student Performances

1. Clamps distributor in a vise.
2. Locates manufacturer's specifications for wear, dwell, and timing advance.
3. Disassembles distributor.
4. Washes, cleans, and inspects parts for wear.
5. Replaces defective parts as necessary.
6. Assembles distributor, checking play tolerances.
7. Checks distributor operation on distributor tester.
8. Makes adjustments as necessary.
9. Uses proper tools.
10. Follows all appropriate safety procedures.
11. Performs tasks in an acceptable amount of time.

Instructor Ratings

Acceptable	Not Acceptable	Omit

SAMPLE

Tools and Equipment

For this objective, you will need to use the tools and equipment listed below. You will be given the procedures for using special tools and equipment as you work through the activities.

Basic Hand Tool Set

Basic Equipment

workbench
machinist's vise
files
air hose
blowgun

Safety Equipment

eye protection

Special Equipment

distributor tester
bushing inserter and remover set
adjustable reamers
distributor vise clamp (if available)

Reading List

If you would like additional information as you work through this performance objective, use the references below.

General Reference

Ellinger, *Automechanics*, pp. (21-18)-(21-19).

Special-Purpose Reference

Crouse, *Automotive Electrical Equipment*, pp. 321-32.

Personal and Service Safety Practices

Safety When Overhauling a Distributor

Correct tools. Always use the correct tools (wrenches, punches, and hones or reamers) to avoid damage to the distributor when overhauling it.

Always use a soft-jawed vise when clamping a distributor at the ribbed section of its housing. This will prevent marking, gouging, or marring of the distributor housing.

Cleanliness. Always clean and lubricate distributor parts as you assemble them. This will assure smooth operation of the distributor.

Eye protection. Always wear eye protection when using punches, drifts, or grinding wheels. Flying metal chips can cause serious injury to your eyes.

Safety When Working around a Distributor Tester

Rotor. Always remove the rotor before doing tests on the distributor tester. An unguarded rotor turning at high speeds can cause damage to tools and equipment, or can cause personal injury.

Eye protection. Always wear eye protection when using a distributor tester. Flying dirt or metal chips can cause serious injury to your eyes.

Drive gear. Do *not* bottom the distributor drive gear or shaft in the tester chuck. This can damage the tester or distributor shaft runout.

Adapters. Always use the proper adapters when mounting a distributor in the tester. This will avoid damage to the distributor.

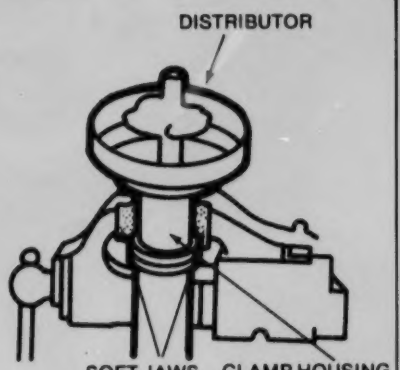
Operating procedures. Follow the distributor tester manufacturer's operating procedures. This will prevent damage to equipment or incorrect test readings due to incorrect equipment calibrations.

Safety in Work Clothes and Grooming

Clothing. Avoid wearing loose clothing or anything that can get caught in moving parts. Wearing loose clothing can cause serious personal injury as well as damage to engine parts.

Hair. Keep hair away from moving parts. If your hair hangs over your collar, wear a hat.

Figure 12-1 Distributor mounted in vise



PREPARING FOR DISTRIBUTOR OVERHAUL

Before overhauling a distributor, you must mount the distributor in a vise and locate the manufacturer's part number on the distributor. You will use this number to find the correct distributor specifications in a technical service manual. You will also use this number when ordering new replacement parts for the distributor.

Mounting a Distributor in a Vise

STEP 1 Clamp the ribbed section of the distributor housing between the jaws of the vise. Be sure the vise is equipped with soft jaws.

STEP 2 Tighten the vise just enough to hold the distributor securely in place. (Do not overtighten, since you could damage the distributor.)

Locating the Distributor Part Number

The manufacturer's part number can be found almost any place on the distributor—for example, on the breaker plate assembly or around the ribbed section of the distributor housing (see Figure 12-2).

Figure 12-2 Two locations of distributor part number

Using the distributor part number, look up the timing advance and dwell specifications in a technical service manual. Also, refer to the distributor manufacturer's overhauling procedures. Although distributors look alike in many cases, specific information from the manufacturer will be very helpful.

Turn to your Review Exercise Book and complete Exercise 17.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

1. **Clamp a distributor in a vise. (page 130)**

2. **Locate the distributor manufacturer's part number. List the specifications for dwell and timing advance mechanisms. (page 130)** *Check your work with your instructor.*

After you have finished these activities, go on to the next section.

OVERHAULING A DISTRIBUTOR

The distributor has three main assemblies: ***the mechanical advance assembly, the breaker plate assembly, and the distributor shaft and drive gear assembly.***

Basically, there are two types of distributors. On one type, the mechanical advance mechanism is located ***above*** the breaker plate and contact point assembly. On the other, the timing advance mechanism is located ***under*** the breaker plate and contact point assembly. You will learn how to overhaul both types of distributors in this performance objective.

Overhauling a Delco-Remy, Window-Type Distributor

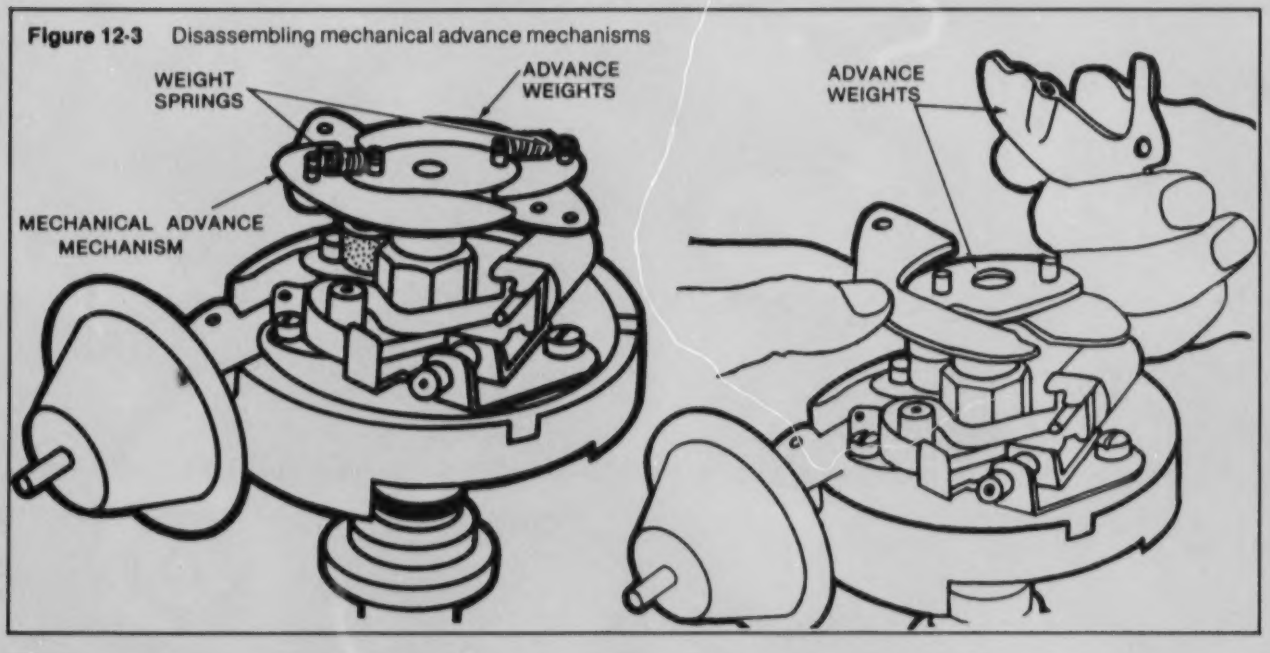
Disassembling the Distributor

Mechanical advance mechanism. The mechanical advance mechanism is the first assembly you must disassemble on the Delco-Remy, window-type distributor. On this distributor the mechanical advance mechanism is located above the breaker plate assembly and contact points.

Here are the steps for disassembling the mechanical advance mechanism. Be sure to keep all parts together as you take the distributor apart. This will make it easier for you to put them back together.

STEP 1 Carefully unhook and remove the distributor weight springs (see Figure 12-3).

Figure 12-3 Disassembling mechanical advance mechanisms



STEP 2 Mark the springs, spring brackets, and adjusting posts. Use masking tape or an awl, and mark the brackets and posts. This will help you to reinstall the weight springs correctly.

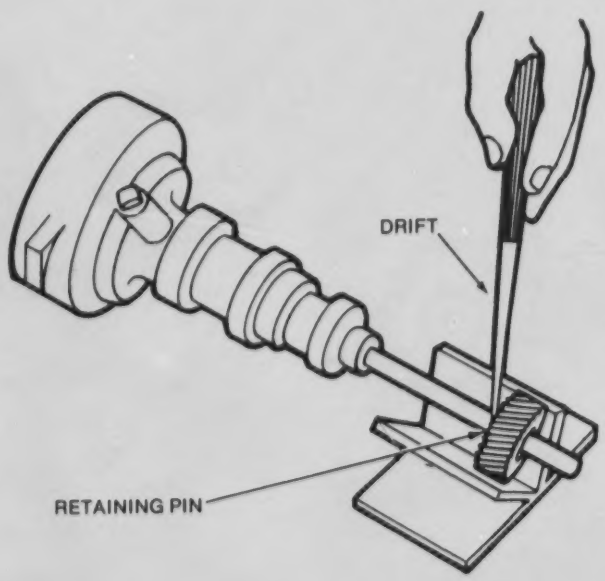
STEP 3 Remove both advance weights.

Distributor shaft and drive gear. The distributor shaft and drive gear is the second assembly you'll need to disassemble on the Delco-Remy, window-type distributor. The drive gear must be removed first. It is located on the bottom end of the distributor shaft.

To disassemble the distributor shaft and drive gear:

STEP 1 Remove the distributor from the vise, and place the shaft in a V-block or other special tool, as shown in Figure 12-4.

Figure 12-4 Removing drive gear



CAUTION: The distributor should be supported in such a way that the distributor shaft will not be damaged when driving the pin out.

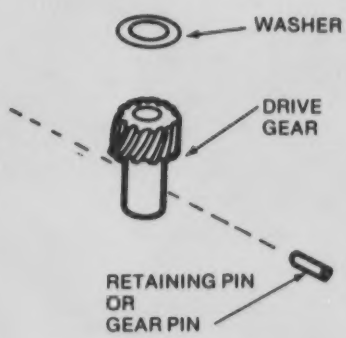


Figure 12-5 Removing drive gear and washer from shaft

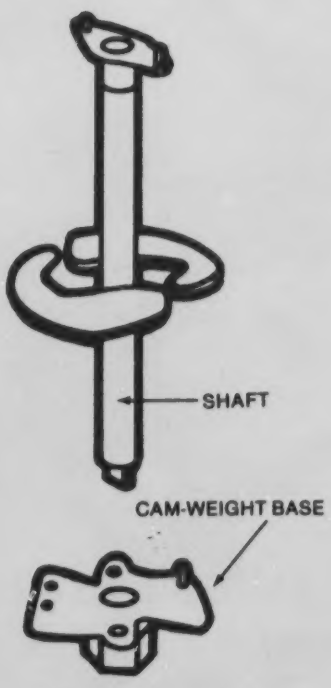


Figure 12-6 Removing distributor shaft and cam-weight base assembly from housing

STEP 2 Remove the retaining pin or gear pin from the distributor drive gear with a pin punch and hammer. Use a starter punch first to work the retaining pin free.

NOTE: The retaining pin is usually peened at the ends. This means it has been flattened at the ends to form a tight lock between the gear and shaft. If you grind off one of these peened ends, you can more easily remove the pin from the other end. You will also be better able to select the punch size that will fit the retaining pin correctly.

STEP 3 Slide the drive gear and washer from the distributor shaft, as shown in Figure 12-5.

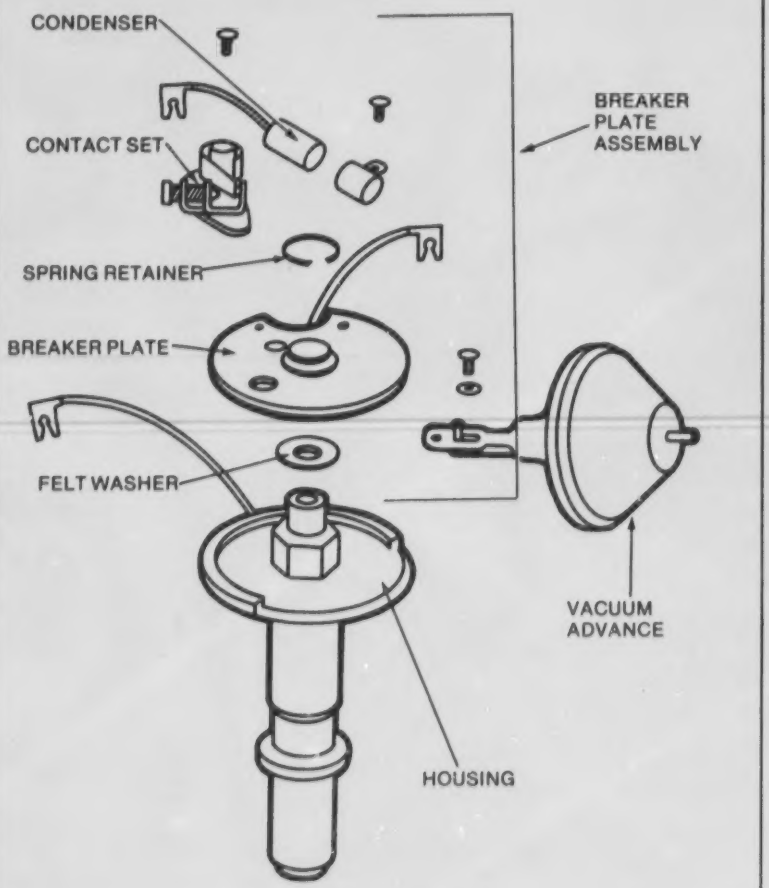
STEP 4 Pull both the distributor shaft and the cam-weight base assembly from the housing at the same time, as shown in Figure 12-6.

Breaker plate assembly. The breaker plate assembly is the last assembly you'll need to disassemble on the Delco-Remy, window-type distributor. The breaker plate assembly is located on the distributor housing.

To disassemble a breaker plate assembly:

STEP 1 Clamp the distributor in the vise again. Remove the R.F.I. shield if the distributor has one. Then, remove the contact points and the condenser (see Figure 12-7).

Figure 12-7 Disassemble breaker plate assembly



STEP 2 Remove the spring retainer and lift the breaker plate from the distributor housing.

STEP 3 Remove the ground lead. Then remove the vacuum advance mechanism attaching screws and remove the mechanism from the distributor housing.

STEP 4 Remove the felt washer from around the bushing in the housing.

Visually Inspecting the Distributor

Wash and clean all of the distributor's moving parts in cleaning solvent, and inspect them for wear. Inspect each of the three main assemblies separately.

Breaker plate assembly. Look at the areas where the assembly comes in contact with another part. If these surfaces are worn or grooved, it indicates that the breaker plate assembly is not moving smoothly or freely, and must be replaced. Replace the contact points and condenser if needed.

Mechanical advance assembly. Look for worn areas where there is metal-to-metal contact. Grooved spots indicate extreme wear and mean that the part should be replaced. Also, check the advance springs for stretched or collapsed coils. These defects indicate that the advance springs should be replaced.

Distributor shaft and drive gear. Look for wear on the distributor shaft where it turns in the bushings. If this area is shiny and worn, both the shaft and the bushings must be replaced. Too much side play in the distributor shaft is another way of telling when the shaft and bushings need replacing. If the drive gear is worn or damaged, it must also be replaced.

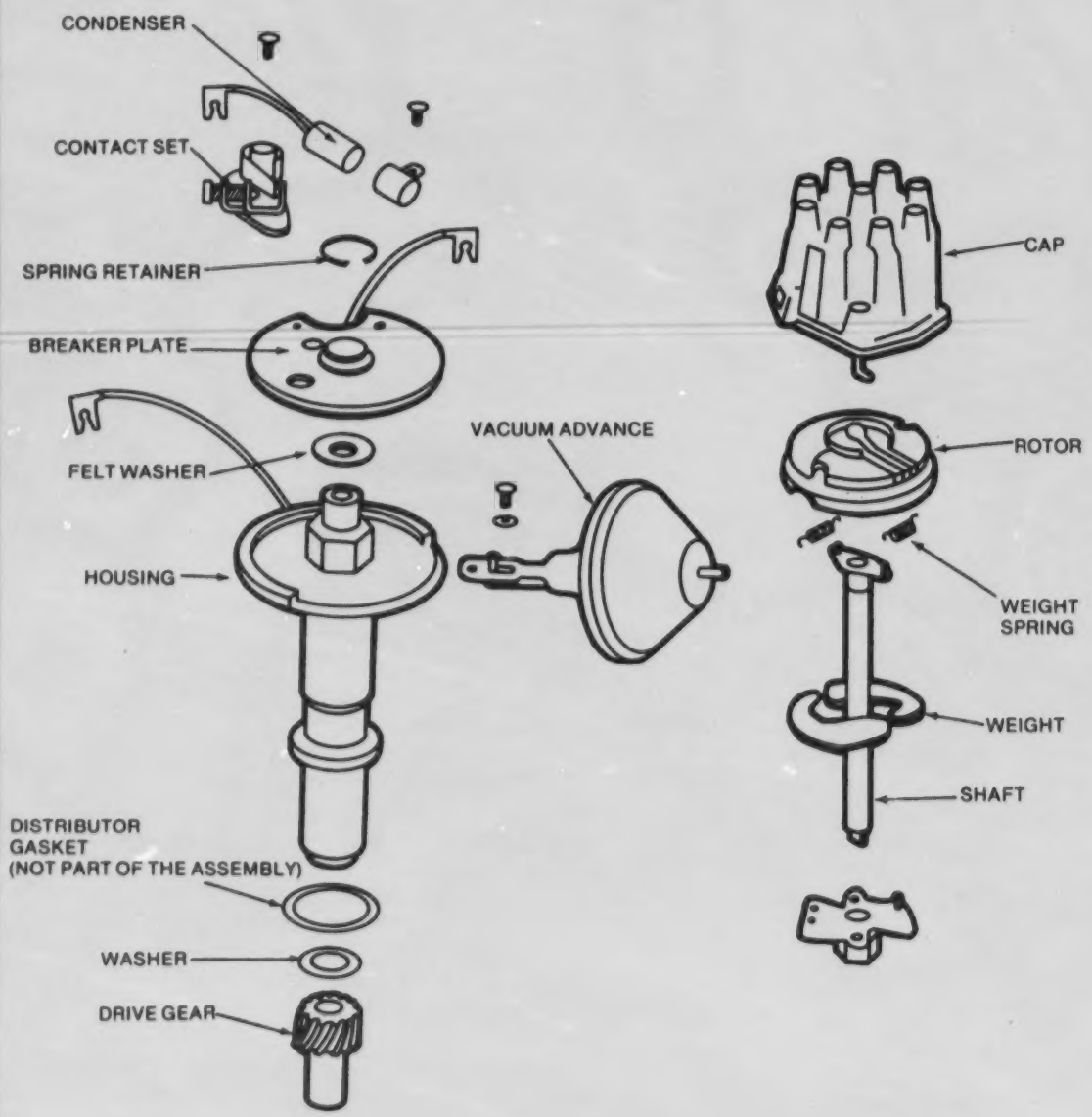
Wash and clean the distributor housing in cleaning solvent. Inspect the distributor shaft bushings and the distributor shaft for wear.

NOTE: Do not service or replace the distributor shaft bushings in the housing. Both the housing and bushings are serviced as a complete unit. Replace the distributor housing if bushings are worn.

Reassembling the Distributor

Follow the same steps for assembling the Delco-Remy, window-type distributor, but reverse the order. Be sure to lubricate the distributor's moving parts as they are reassembled. Follow the exploded view of the distributor shown in Figure 12-8 as you reinstall the three assemblies.

Figure 12-8 Exploded view of Delco-Remy distributor



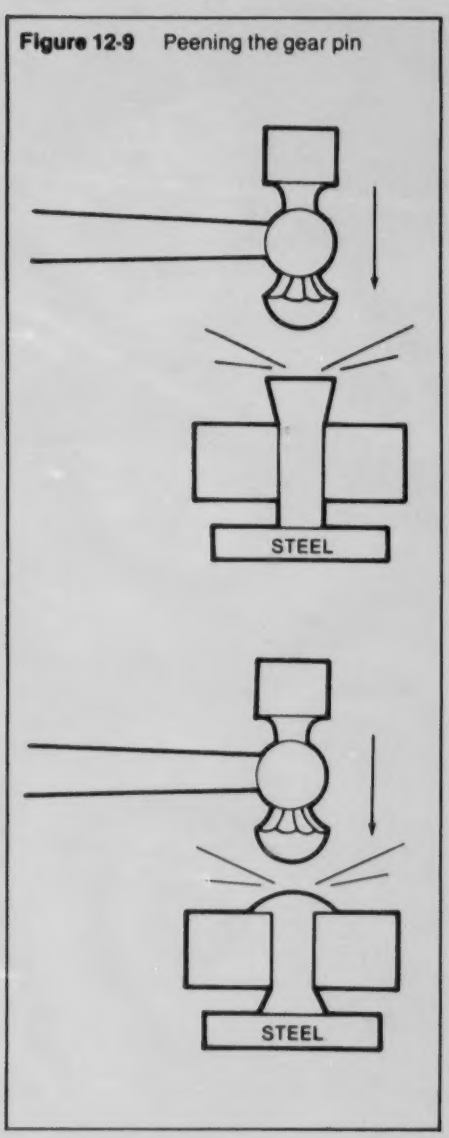


Figure 12-9 Peening the gear pin

Breaker plate assembly.

STEP 1 Mount the distributor in a vise and install the felt washer around the upper bushing in the distributor housing.

STEP 2 Install the vacuum advance mechanism and the ground lead in the distributor.

STEP 3 Coat the friction or bearing surfaces of the breaker plate assembly with heat-resistant lubricant, and position the plate assembly on the housing. Install the spring retainer.

STEP 4 Install the contact points and condenser.

Distributor shaft and drive gear.

STEP 1 Coat the distributor shaft with oil. Coat the distributor cam with cam lubricant. Slide the distributor shaft and cam-weight assembly into the distributor housing. Turn the shaft so that the flat side of the cam will pass by the contact points.

STEP 2 Remove the distributor from the vise and support it properly in a V-block.

STEP 3 Install the distributor drive gear on the shaft. Align the hole in the gear to the hole in the shaft and insert the retainer pin.

NOTE: Always use a ***new*** retainer or gear pin. The pin must fit tightly in the hole to prevent any movement between the gear and the shaft. Be sure to support the distributor properly to avoid damaging it.

Peen (or round over) the ends of the pin to lock it in place. To do this, rest one end of the pin on a block of steel and tap the other end with the ball peen part of the hammer, as shown in Figure 12-9.

Mechanical advance mechanism. Clamp the distributor back in the vise. Using a lightweight grease, lubricate the pivot posts of the advance weights. Assemble the mechanical advance mechanism. Be sure you install the right weight springs on the right posts.

Checking Distributor Operation on a Distributor Tester

The reassembled (or overhauled) distributor is now ready for operational checks, tests, and adjustments on the distributor tester.

After performing the necessary checks and adjustments, reinstall the R.F.I. shield if the distributor has one.

To review distributor tester operation procedures and distributor tests and adjustments, refer to Performance Objective 11.

Turn to your Review Exercise Book and complete Exercise 18.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

3. Disassemble a Delco-Remy, window-type distributor. (pages 132-135)

4. Wash, clean, and inspect all the distributor parts for wear. Write down the names of the parts that should be replaced. (pages 135-136) *Check your work with your instructor.*

5. Assemble a Delco-Remy, window-type distributor. (pages 136-138)

6. Check distributor operation on a distributor tester. (Performance Objective 11) *Check your work with your instructor.*

After you have finished these activities, go on to the next section.

Overhauling a Ford or Chrysler Distributor

Before disassembling the Ford or Chrysler distributor, clamp the distributor in a vise. Then, locate the distributor part number.

Look up the timing advance and dwell specifications in a technical service manual. In addition to these specifications, refer to the distributor overhaul procedures for the distributor you'll be overhauling. Although distributors look alike in many cases, specific information furnished by the vehicle manufacturer will be very helpful.

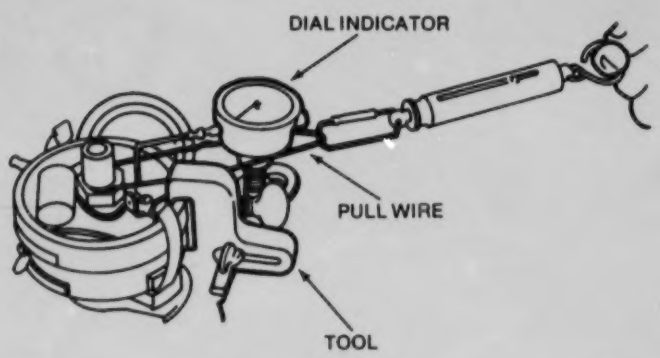
Checking the Distributor Shaft and Bushing for Wear

When the distributor shaft bushings are worn they allow too much distributor shaft side play, and must be replaced. Some manufacturers allow up to .006 inch side play before recommending replacement. Look for the specifications in your technical service manual.

To check distributor shaft side play:

STEP 1 With the distributor clamped in the vise, install a dial indicator on the distributor housing so that the dial indicator plunger rests against the movable contact point arm, as shown in Figure 12-10. The rubbing block should be resting on the high point of the cam.

Figure 12-10 Checking distributor shaft side play



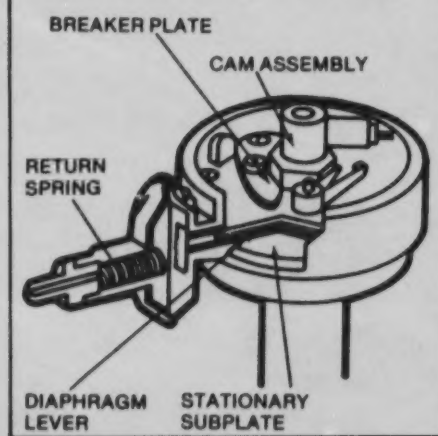
STEP 2 Set the dial indicator at zero.

STEP 3 Place a wire loop around the upper part of the distributor shaft and hook a spring scale on the other end of the loop.

STEP 4 Apply a one-pound pull in line with the dial indicator plunger and read the movement on the indicator dial. (Some manufacturers specify a five-pound pull.)

NOTE: If the distributor shaft has excessive side play, a new or rebuilt distributor will be needed.

Figure 12-11 Breaker plate assembly

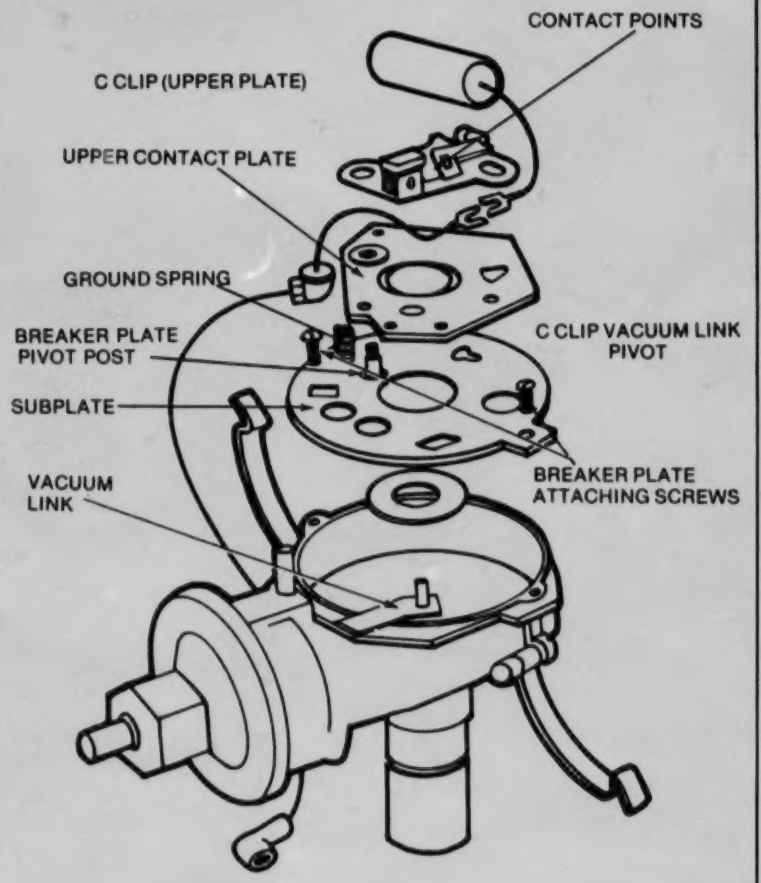


Disassembling the Distributor

Breaker plate assembly. The breaker plate assembly is the first assembly you will need to disassemble. On Ford and Chrysler distributors, the breaker plate assembly is located above the mechanical advance mechanism, as shown in Figure 12-11.

The following exploded view of a Ford breaker plate assembly shows you how the assembly can be taken apart (see Figure 12-12). Notice the breaker plate (upper contact plate) and the subplate labelled in the diagram below. As you disassemble the breaker plate assembly, you will also need to separate the upper plate from the subplate. The steps for separating these two plates are included on the next page.

Figure 12-12 Exploded view of Ford breaker plate assembly



Be sure to keep all parts together as you take apart the breaker plate assembly as well as other parts. This will make it easier for you to put them back together.

STEP 1 Remove the contact points and condenser.

STEP 2 Remove the C-clip from the vacuum pivot post.

STEP 3 Remove the screws that attach the breaker plate assembly to the distributor body, and remove the breaker plate assembly.

To separate the breaker plate from the subplate:

STEP 1 Remove the large C-clip from the upper plate pivot post.

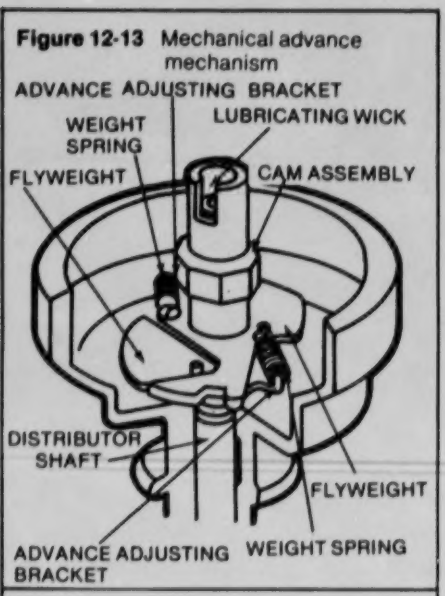


Figure 12-13 Mechanical advance mechanism

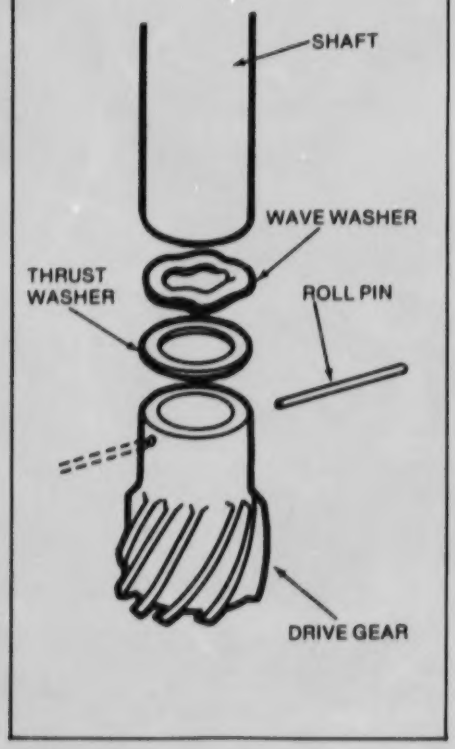


Figure 12-14 Removing drive gear and washers from shaft

STEP 2 Remove the flat washer, wave washers, and upper contact plate.

CAUTION: Do *not* lose the ground spring, which is located between the upper and lower plates.

STEP 3 Remove the rubber grommet (loop) that holds the primary coil wire in place.

Mechanical advance mechanism. The mechanical advance mechanism is located under the breaker plate assembly. 'e Inspect the mechanism to make sure the flyweights are free (see Figure 12-13). You will not disassemble this mechanism. disassemble this mechanism.

Distributor shaft and drive gear. Here are the steps for disassembling the distributor shaft and drive gear on a Ford or Chrysler distributor. (The drive gear is sometimes made of plastic and may need to be replaced.)

STEP 1 Remove the distributor from the vise and place the shaft in a V-block or a special holding or mounting tool.

STEP 2 Remove the retaining pin or roll pin from the distributor drive gear by working it loose with a starter punch. Then drive it out of the gear with a pin punch and a hammer.

NOTE: The retaining pin is usually peened at the ends to form a tight lock between the gear and the shaft. If you grind off one end, you can more easily remove the pin from the other end. You can also more easily select the punch size that will correctly fit the retaining pin.

STEP 3 Slide the gear, thrust washer, and wave washer from the distributor shaft, as shown in Figure 12-14.

Visually Inspecting the Distributor

Wash and clean all the distributor's moving parts in cleaning solvent and inspect them for wear.

Breaker plate assembly. Look at the points where the assembly moves against other parts. If parts are worn or grooved at any point, the assembly will not move freely. The plate assembly must be replaced. Replace the contact points and condenser if needed.

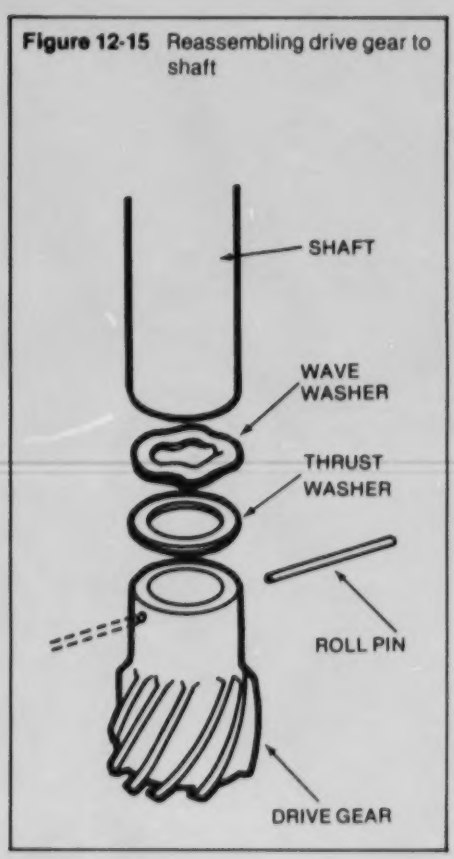


Figure 12-15 Reassembling drive gear to shaft

Mechanical advance assembly. Look for signs of wear in areas where there is metal-to-metal contact. Grooved spots indicate extreme wear and mean that the assembly should be replaced. Also, look at the advance springs for stretched or collapsed coils. These defects indicate that the advance springs should be replaced.

Reassembling the Distributor

The assembly procedures for a Ford or Chrysler distributor are the reverse order of the disassembly procedures you have just learned. Be sure to lubricate the distributor's moving parts as you reassemble them.

Distributor shaft and drive gear. To reassemble the distributor shaft and drive gear on a Ford or Chrysler distributor:

STEP 1 Remove the distributor from the vise. Slide the wave washer, thrust washer, and drive gear onto the distributor shaft. Align the hole in the gear with the hole in the shaft, and insert the retainer pin or roll pin, as shown in Figure 12-15.

STEP 2 Support the distributor properly on a V-block or special mounting tool, and press or drive the pin into the distributor shaft.

STEP 3 Peen (or round over) the ends of the pin to lock it in place. To do this, rest one end of the pin on a block of steel and tap the other with the peen part of the hammer. Peen solid pins only. Do *not* peen split-type, self-locking pins.

Breaker plate assembly. To reassemble the breaker plate assembly on a Ford or Chrysler distributor:

STEP 1 Lubricate all the surfaces of the breaker plate assembly parts with a thin coat of grease.

STEP 2 Install the rubber grommet in the lower plate. Be sure to leave enough wire to reach the contact points connection (see Figure 12-16).

Figure 12-16 Exploded view of breaker plate assembly

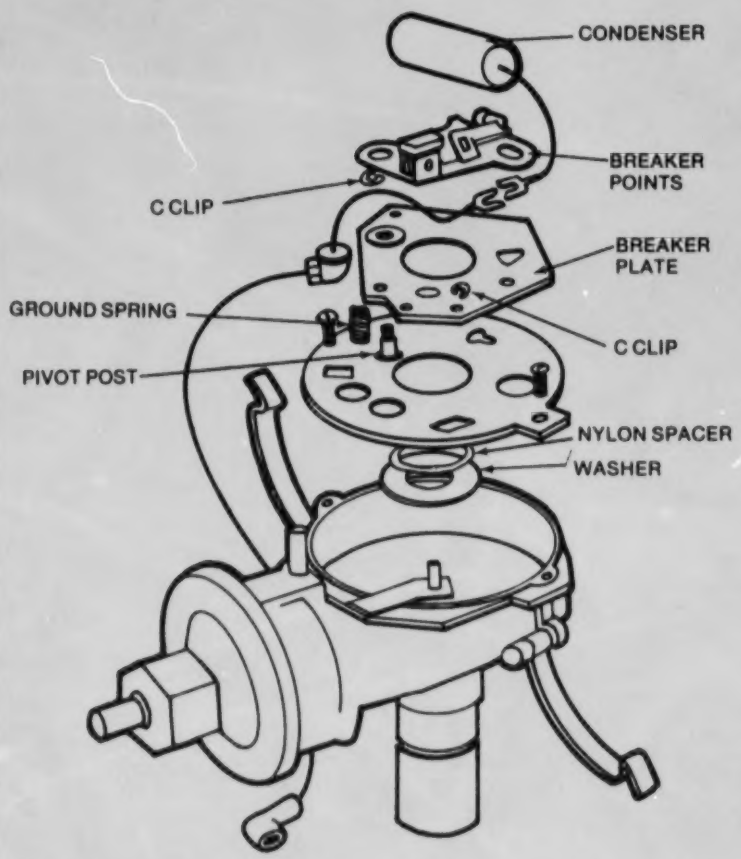
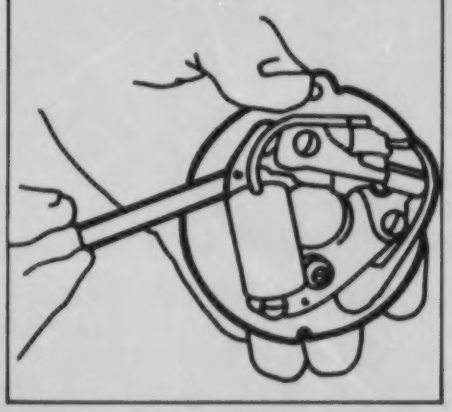


Figure 12-17 Gauging breaker plate and subplate



STEP 3 Connect the ground spring to the pivot post.

STEP 4 Install the upper breaker plate. Place the flat washers and wave washers over the pivot post. Secure the assembly with the large C-clip.

STEP 5 Look up the clearance specifications in a technical service manual. Check the clearance between the breaker plate and subplate, using the correct feeler gauge.

- Place the feeler gauge between the plates where specified by the vehicle manufacturer (see Figure 12-17).

- Adjust the plates to obtain the clearances specified by the vehicle manufacturer's procedures.

STEP 6 Place the breaker plate assembly into the distributor body. Install the two attaching screws and tighten them securely.

STEP 7 Install the C-clip on the vacuum unit pivot post.

STEP 8 Lubricate the distributor cam with cam lubricant. Then install the contact points and condenser.

Checking Distributor Operation on a Distributor Tester

The distributor is now ready to be checked, tested, and adjusted, using a distributor tester.

To review distributor tester operating procedures, distributor tests, and adjustments, turn to Performance Objective 11.

Turn to your Review Exercise Book and complete Exercise 19.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

7. Disassemble a Ford or Chrysler distributor. (pages 140-142) *Check your work with your instructor.*

8. Wash, clean, and inspect all distributor parts for wear. Write down the names of the parts that should be replaced. (pages 142-143) *Check your work with your instructor.*

9. Remove and replace the distributor shaft drive gear. (page 143) *Check your work with your instructor.*

10. Assemble a Ford or Chrysler distributor. (pages 143-145) *Check your work with your instructor.*

11. Check distributor operation on a distributor tester. (see Performance Objective 11) Check your work with your instructor. *structor.*

When you have finished these activities, ask your instructor to return your pretest on Performance Objective 12. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will then tell you if you are ready to be checked off on the performance checklist or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

PERFORMANCE OBJECTIVE 13

INSPECT AND TEST THE PRIMARY CIRCUIT

INTRODUCTION TO P.O. 13

In this performance objective, you will test the primary ignition circuit, using both a voltmeter and an ignition oscilloscope.

After you have finished all the work activities for Performance Objective 13, your instructor will use a checklist like the one below to evaluate your work.

PERFORMANCE CHECKLIST—P.O. 13

The instructor will provide either a live vehicle or a live engine. Test the primary circuit. All of the performances below must be accomplished.

Student Performances	Instructor Ratings		
	Acceptable	Not Acceptable	Omit
1. Visually checks spark intensity, primary wiring, and coil polarity.			
2. Tests the battery voltage.			
3. Tests primary circuit resistance with voltmeter.			
4. Checks primary circuit continuity.			
5. Checks contact point dwell and point resistance.			
6. Tests condenser, as necessary.			
7. Makes appropriate voltage output tests.			
8. Tests ballast resistor.			
9. Tests coil (draw, resistance).			
10. Hooks up oscilloscope.			
11. Tests primary circuit with scope.			
12. Reports any malfunctions or necessary repairs.			
13. Uses proper tools and equipment.			
14. Follows all appropriate safety precautions.			
15. Performs tasks in an acceptable amount of time.			

SAMPLE

Tools and Equipment

For this objective, you will need to use the tools and equipment listed below. You will be given the procedures for using special tools and equipment as you work through the activities.

Basic Hand Tool Set

Basic Equipment

fender covers
extension light
continuity light
voltmeter
ammeter
tachometer
ohmmeter

Special Equipment

coil condenser tester
oscilloscope

Reading List

If you would like additional information as you work through this performance objective, use the references below.

General References

Crouse, *Automotive Mechanics,* pp. 310-14.

Crouse, *The Auto Book,* Ch. 26.

Ellinger, *Automechanics,* Ch. 17-18.

Ellinger, *Auto Service and Repair,* pp. (23-1)-(23-31).

Special-Purpose Reference

Crouse, *Automotive Electrical Equipment,* Ch. 13-14.

Personal and Service Safety Practices

Safety When Making an Electrical Test

Correct procedures. Follow the electrical test equipment manufacturer's procedures. Carefully follow the manufacturer's instructions for making equipment calibrations as well as for using and taking care of the equipment.

Personal safety. *Never* do any electrical tests when standing on a wet floor or when vehicle or engine parts are wet.

Safety When Making Ignition Tests with an Oscilloscope

Scope leads. Always keep the scope leads away from fan belts and engine fan blades.

Be sure that all the test leads are properly connected and are according to the manufacturer's specifications for the equipment.

Safety When Working around an Operating Engine

Fender covers. Always use fender covers when doing work under the hood. This prevents scratching the finish on the fenders.

Personal safety. Avoid reaching without looking. Your fingers could get caught by moving parts when the engine is cranking or operating.

Safety in Work Clothing and Grooming

Metal. Avoid wearing any metal (rings, buckles, wristwatches, bracelets, necklaces) that may come in contact with an electrical part. You can receive a severe burn and can also damage the electrical unit.

Loose clothing. Avoid wearing loose clothing or anything that can get caught by moving parts. Injury can result.

Hair. Keep hair away from moving parts. If your hair hangs over your collar, wear a hat.

TESTING THE PRIMARY IGNITION CIRCUIT WITH A VOLTMETER

Problems in the primary ignition circuit are caused by high resistance to primary current flow, poor connections, and components that are not functioning properly. These problems cause missing (or misfiring), hard starting, no starting, loss of power in acceleration or at high speed, and rough idle.

By using the following procedures, you will be able to find out whether there is too much resistance to current flow in the primary circuit. Procedures are given for both visual checks and for step-by-step voltage drop tests.

Visual Checks

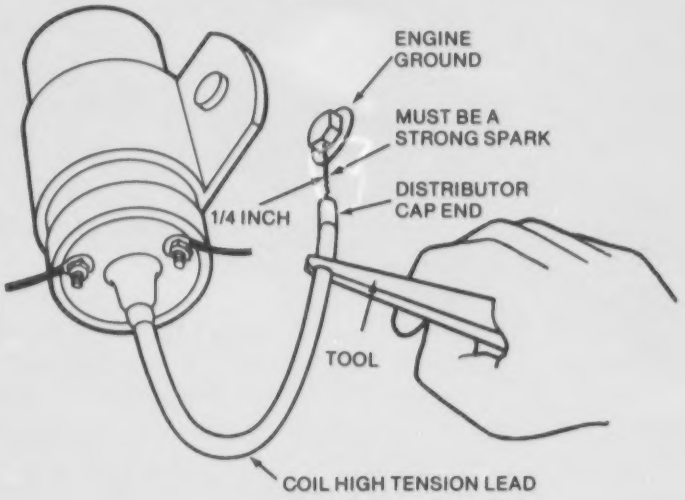
Spark intensity test at the coil. This test is to find out if you have a good spark, a weak spark, or no spark coming out of the high-tension lead of the coil. Through this test, you can quickly tell if there is a problem in the primary circuit, the coil, or the coil high-tension lead.

CAUTION: Do not perform this test on electronic ignition systems. If you do, you may damage the electronic control unit or module.

To do a spark intensity test at the coil:

STEP 1 Remove the coil high-tension lead from the center of the distributor cap. Use the insulated holding tool, as shown in Figure 13-1.

Figure 13-1 Performing spark intensity test at coil



STEP 2 Hold the free end of the high-tension lead about 1/4 inch away from a good engine ground.

STEP 3 Have an assistant crank the engine from inside the vehicle. Observe the spark.

A good spark must be bright in color and must discharge itself with a solid snap. It must be a full spark, ***not*** thin, skinny, or thready. A weak spark or no spark means that there is trouble in the primary ignition circuit. Further checks and tests are necessary.

STEP 4 Reinstall the coil high-tension lead into the distributor cap.

Primary wiring and connections. This test is to find out if all primary wiring and connections are in good working condition. Remember, the primary circuit consists of ***all*** the following parts: battery, battery cables and connections, starter relay or solenoid, ignition switch, resistance wire or ballast resistor, bypass wire, coil, contact points, and condenser (see Figure 13-2).

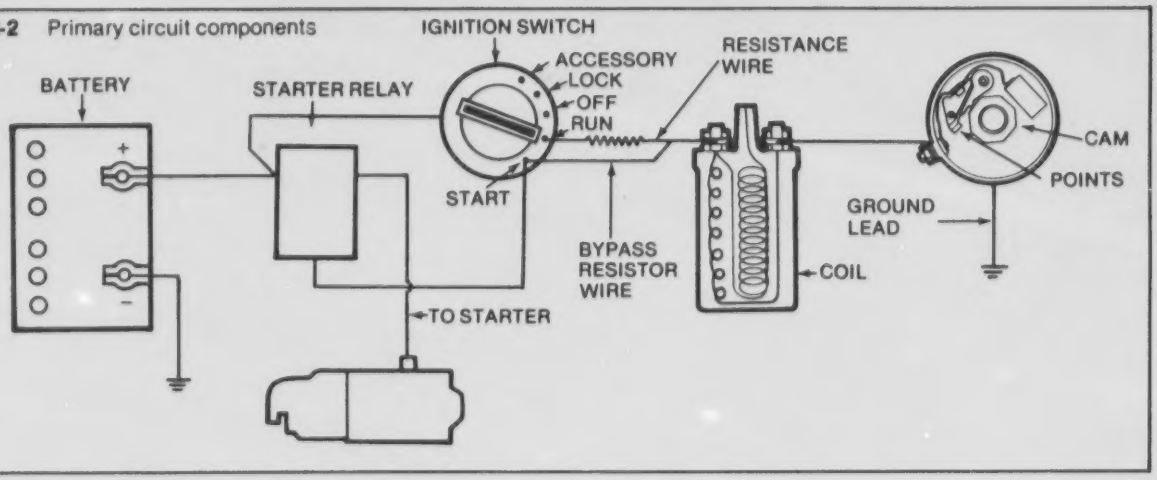


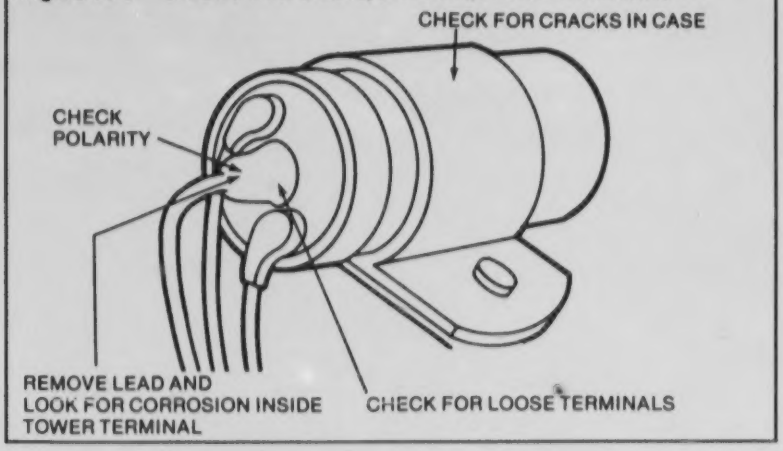
Figure 13-2 Primary circuit components

STEP 1 Check all primary wiring for loose connections, corroded connections, grounding of a bare wire, and cut, frayed, or burned wiring.

STEP 2 Tighten all loose connections. Repair or replace any corroded or damaged wires.

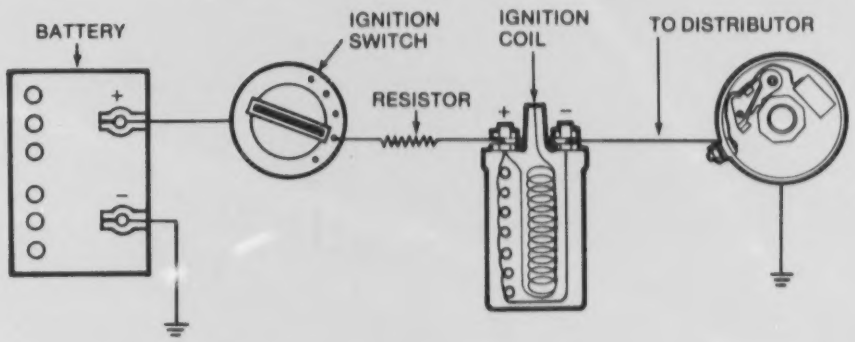
STEP 3 Check all coil and coil lead connections for loose terminals, dirty or corroded terminals, and corrosion inside the tower terminal (see Figure 13-3). Tighten all lead connections if needed.

Figure 13-3 Check coil for cracks, corrosion, and loose terminals


CHECK FOR CRACKS IN CASE
CHECK POLARITY
REMOVE LEAD AND LOOK FOR CORROSION INSIDE TOWER TERMINAL
CHECK FOR LOOSE TERMINALS

Coil polarity check. Coil polarity is the term for the direction of flow of primary current through the coil. If the vehicle is negative ground, the POS, or BAT, terminal of the coil must have the lead from the battery side of the primary circuit connected to it. The lead to the distributor must be connected to the NEG, or DIST, terminal of the coil (see Figure 13-4). Identifying marks are beside each coil terminal. Check each coil terminal and the leads to be sure connections are correct, since reverse polarity will affect the performance of the engine.

Figure 13-4 Primary circuit coil connections



Battery Voltage Test

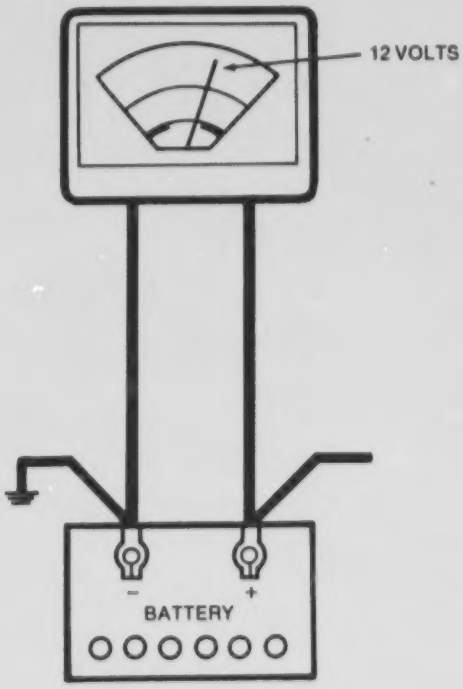
The first voltage test to be done in testing primary circuit resistance is the battery voltage test. If a weak spark resulted from the spark intensity test at the coil, check the battery before proceeding.

To test the battery:

STEP 1 Attach the voltmeter test leads to the battery terminals (positive to positive and negative to negative).

STEP 2 The voltmeter reading should be approximately 12 volts. If it is lower, check and service the battery before proceeding (see Figure 13-5).

Figure 13-5 Checking battery voltage



Turn to your Review Exercise Book and complete Exercise 20.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

1. **Do a spark intensity test at the coil. (pages 152-153)**
2. **Visually check the primary circuit wiring, connections, and coil polarity. Make a list of the defects you find. (pages 153-154)**
3. **Test the battery voltage. Record your results. (page 154-155)**

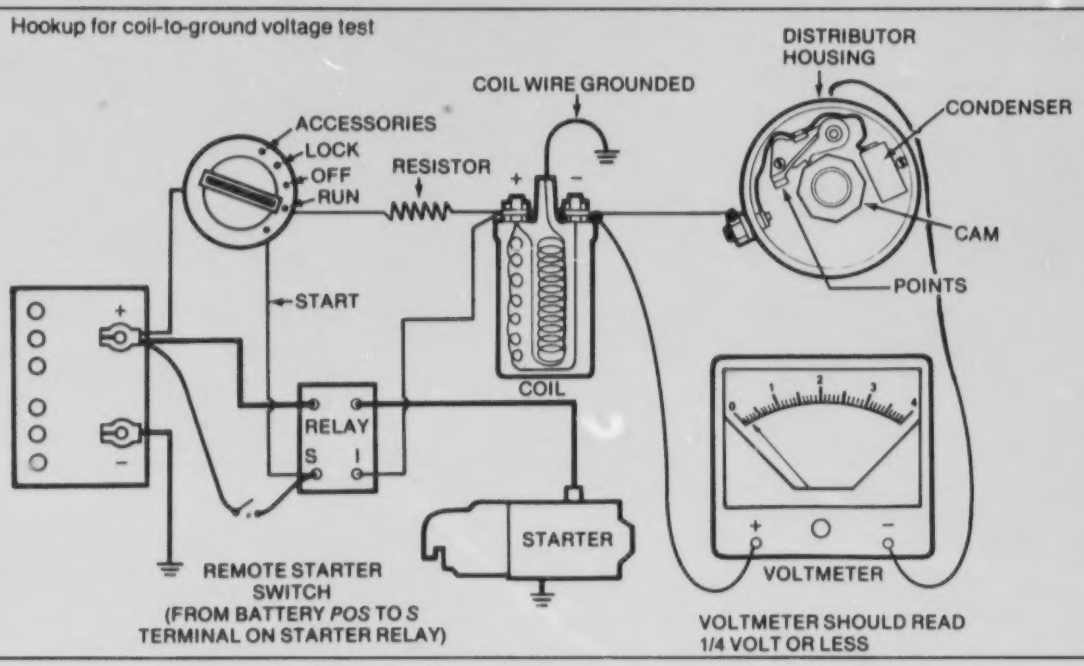
Check your work with your instructor.

After you have finished these activities, go on to the next section.

Coil-to-Ground Voltage Test

The coil-to-ground test measures the amount of voltage drop across the contact points and distributor to ground. You will recognize this test as the same one you did when testing contact point resistance (voltage drop) with the ignition switch on *run*, the points closed, and all lights and accessories *off*.

Figure 13-6 Hookup for coil-to-ground voltage test



To do the coil-to-ground voltage test:

STEP 1 Attach the remote start switch as shown in Figure 13-6.

STEP 2 Turn the ignition switch *on*.

STEP 3 Connect the positive test lead of the voltmeter to the primary (–) terminal on the distributor side of the coil.

STEP 4 Connect the ground (black) voltmeter test lead to the distributor housing.

STEP 5 Turn the voltmeter knob to the 4.0 scale.

STEP 6 Remove the coil wire from the center of the distributor cap. Connect a jumper lead to the coil wire and ground so that the engine won't start.

STEP 7 Crank the engine until the points are closed.

STEP 8 Note the voltage reading. If it is .25 volt or less, the primary circuit resistance from coil to ground is okay.

If the voltage reading is more than .25 volt, there is too much

resistance caused by improperly installed contact points, burned points, misaligned points, or loose leads and ground wires in the distributor.

To pinpoint which of the parts (points, leads, wires) is at fault, continue with the following tests.

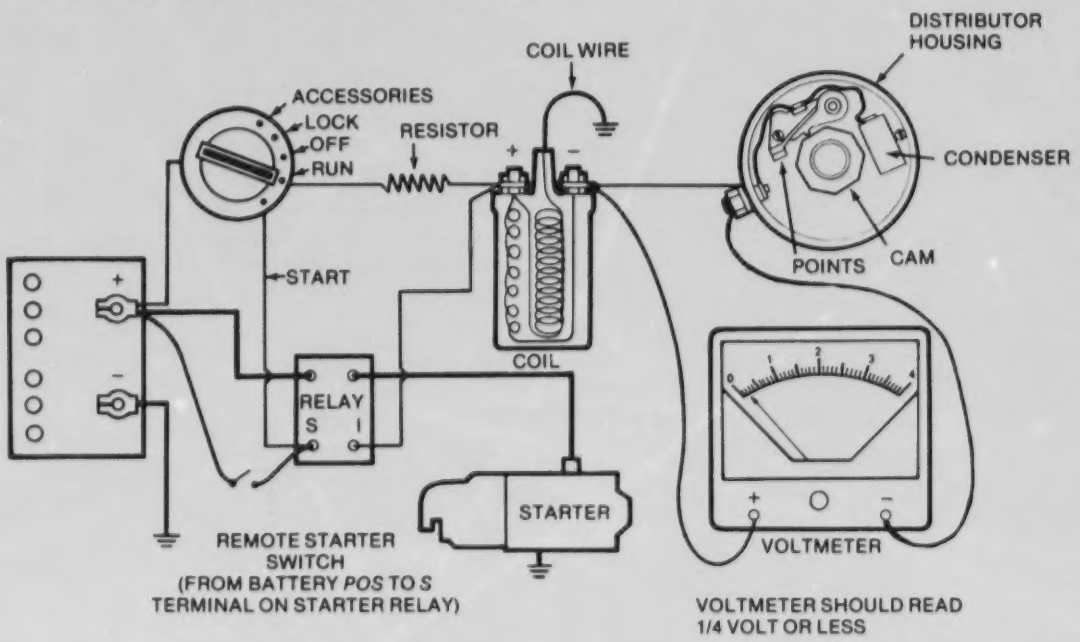
Primary distributor wire high resistance test.

STEP 1 Leave the positive voltmeter test lead connected to the (–) terminal on the distributor side of the coil.

STEP 2 Connect the ground (black) voltmeter test lead to the contact point terminal in the distributor, as shown in Figure 13-7.

If the voltmeter reading is .25 volt or more, the coil-to-distributor wire should be replaced.

Figure 13-7 Hookup for primary distributor wire high resistance test



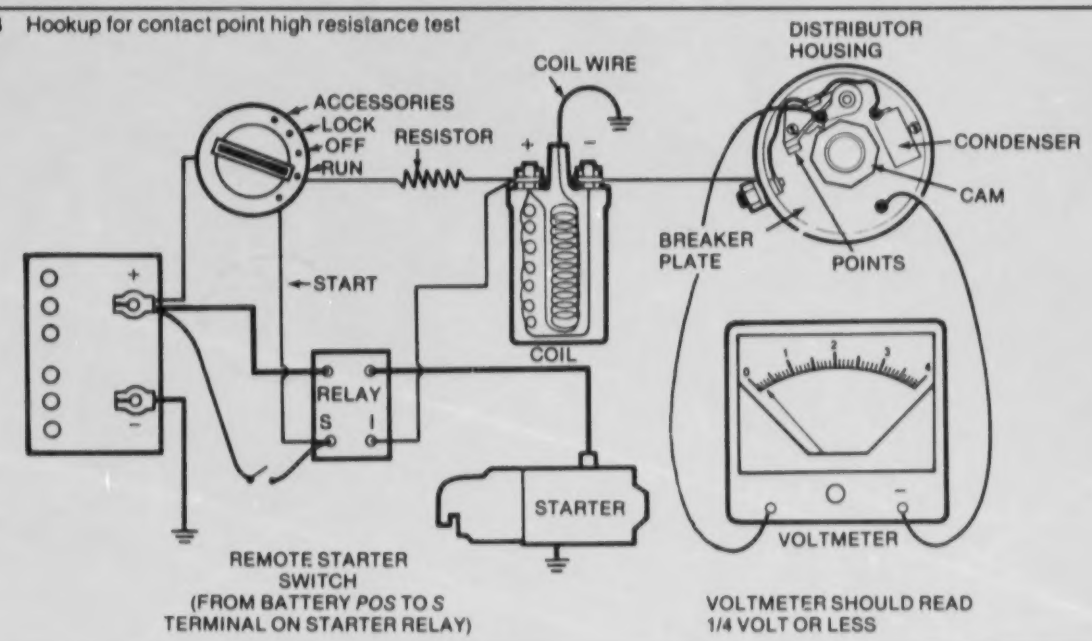
Contact point high resistance (voltage drop) test.

STEP 1 Connect the positive voltmeter test lead to the movable breaker point, as shown in Figure 13-8.

STEP 2 Connect the ground (black) voltmeter test lead to the distributor breaker plate.

If the voltmeter reading is .25 volt or more, the contact points should be replaced.

Figure 13-8 Hookup for contact point high resistance test



Contact point ground wire high resistance (voltage drop) test.

STEP 1 Connect the positive voltmeter test lead to the distributor breaker plate, as shown in Figure 13-9.

STEP 2 Connect the ground (black) voltmeter test lead to the distributor housing.

If the voltmeter reading is .25 volt or more, the contact point ground wire should be replaced. If there is no voltage drop, wiggle the wire and connections with a screwdriver and note the voltmeter reading. If the voltmeter reading remains the same, there are no loose connections. Remember, this wire flexes every time the breaker plate assembly moves.

Distributor ground high resistance (voltage drop) test.

STEP 1 Connect the positive voltmeter test lead to the distributor housing, as shown in Figure 13-10.

STEP 2 Connect the ground (black) voltmeter test lead to a good engine ground.

If the voltmeter reading is .25 volt or more, the distributor should be removed and its base and the engine block cleaned.

STEP 3 Turn the ignition switch off.

Figure 13-9 Hookup to test contact point ground wire

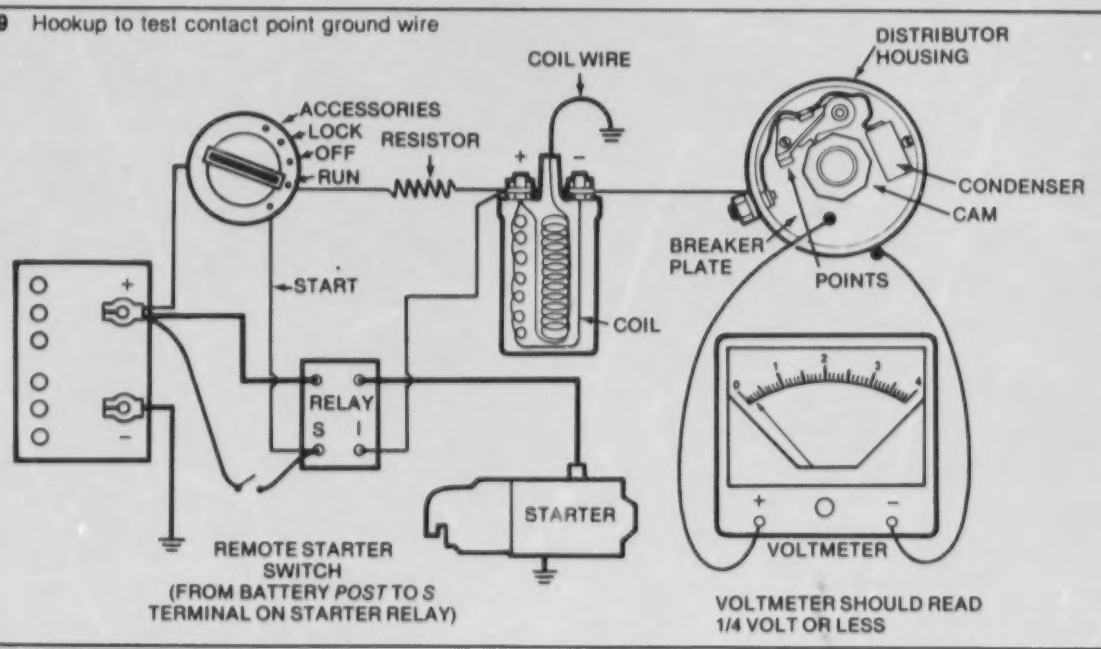
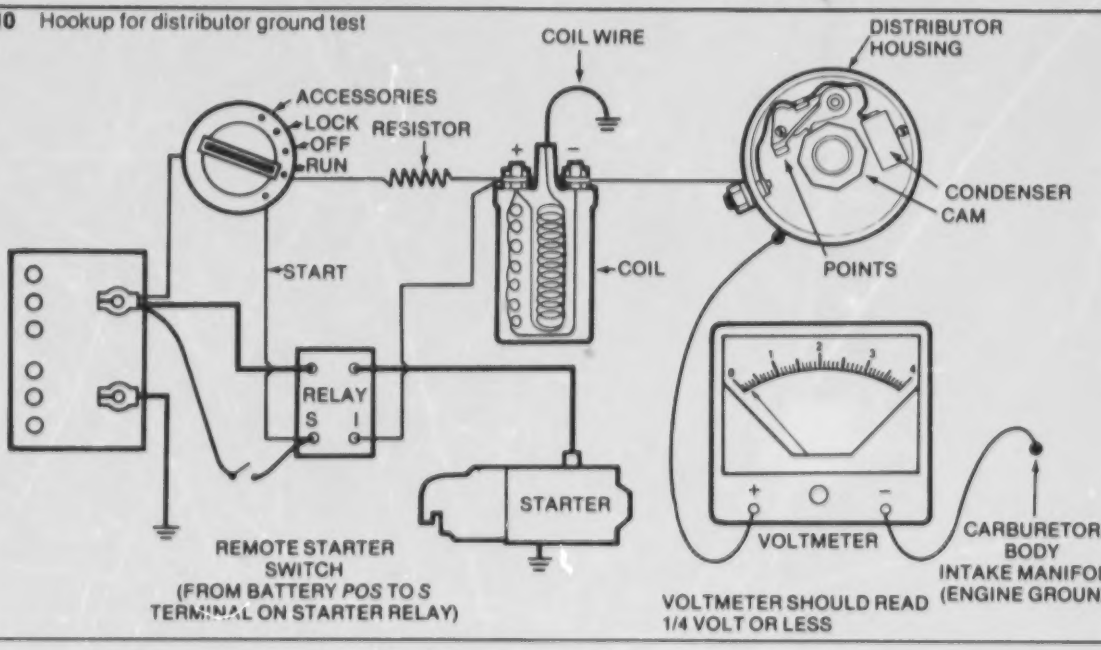


Figure 13-10 Hookup for distributor ground test



Open Circuit Test with a Continuity Test Light

The continuity test light is used to test an *open* primary ignition circuit. After a spark intensity test of the coil in which no spark was visible, the continuity light can be used to find out where the primary circuit is *open*.

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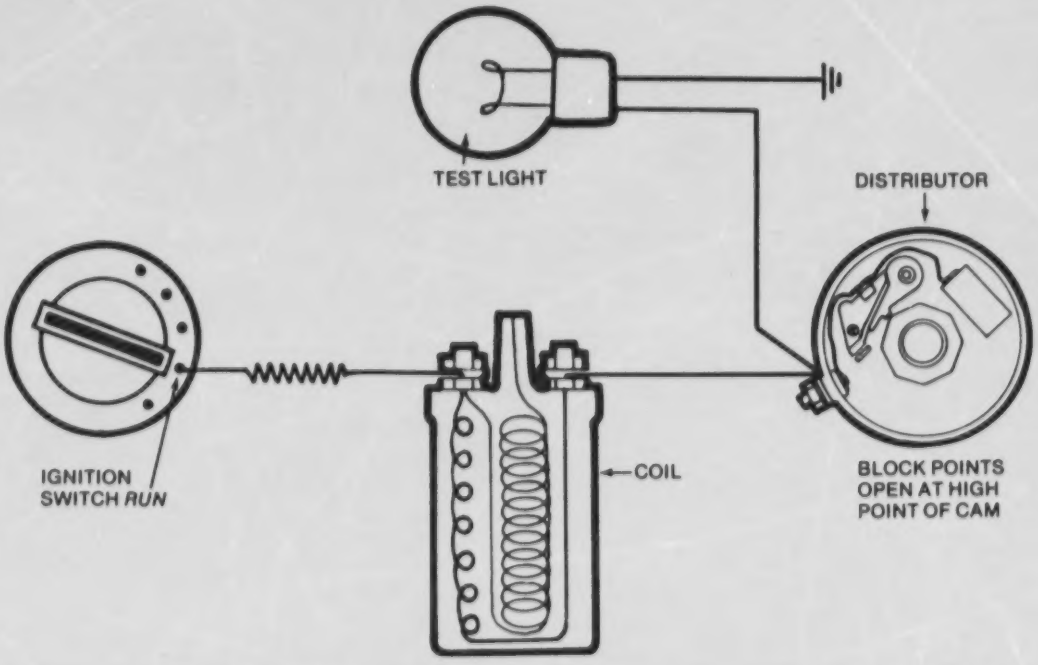
Figure 13-11 Open circuit test



To do the open circuit test:

STEP 1 Block the contact points open. (Use a clean piece of thick paper or a matchbook cover.) Turn the ignition switch to the *run* position (see Figure 13-11).

STEP 2 Attach one test lead to ground and the other test lead to the distributor primary terminal.

When the light does not go on, it means that the open circuit lies somewhere between that point and the ignition switch, or even as far back as the battery.

STEP 3 With the continuity light, trace the primary circuit from the primary distributor terminal to the primary coil terminal, to the ignition switch, and so on. Use the test lead that was attached to the distributor primary terminal as a probe. Leave the other test lead connected to ground. If necessary, trace the circuit all the way back to the battery until the open circuit is pinpointed.

When the continuity light lights up, check for trouble between that point in the primary circuit and the last point where the light did not go on.

STEP 4 Turn the ignition switch off.

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Contact Point Dwell Test

If you find it necessary to review contact point dwell tests and adjustments, refer to Performance Objective 9.

Condenser Test

If you find it necessary to review condenser test procedures, refer to Performance Objective 9.

Turn to your Review Exercise Book and complete Exercise 21.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

4. Using a voltmeter, test the primary circuit (coil-to-ground) resistance (voltage drop). Write down the voltmeter reading. (pages 156-157)

5. Using a voltmeter, test the primary distributor wire for resistance. Write down the voltmeter reading. (page 157)

6. Using a voltmeter, test the contact points for resistance. Write down the voltmeter reading. (pages 157-158)

7. Using a voltmeter, test the contact point ground wire for resistance. Write down the voltmeter reading. (page 158)

8. Using a voltmeter, test the distributor ground for resistance. Write down the voltmeter reading. (pages 158-159) *Check your work with your instructor.*

9. Using a continuity test light, test the primary circuit for an open circuit. (pages 159-160) *Check your work with your instructor.*

10. Check the distributor contact point dwell settings as needed. (page 161) *Check your work with your instructor.*

11. Test the condenser as needed. (page 161) *Check your work with your instructor.*

After you have finished these activities, go on to the next section.

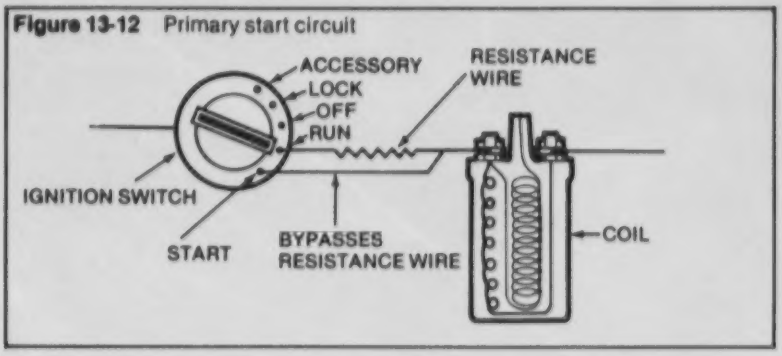
Primary Start Voltage Tests

The next few tests measure voltage and resistance in the primary circuit when the engine is starting. You will notice in Figure 13-12 that the ignition switch is on start, which allows the voltage to bypass the resistance wire or ballast resistor. This is often called the ***bypass system***. Its purpose is to provide a higher coil input voltage for engine cranking.

A faulty bypass system means that the engine is hard to start, especially in cooler weather.

The bypass system involves the following primary ignition parts:

Figure 13-12 Primary start circuit



the starter relay connection, the relay lead to the ignition switch, the switch and connector, and the ignition lead to the coil.

There are two tests that are done with a voltmeter while cranking the engine. One is the ***cranking voltage*** test, or ***available voltage*** test, at both the battery and coil. The other one is a ***circuit resistance*** test. The voltage output test tells you if the proper voltage is supplied in the primary start circuit. The circuit resistance test is used to locate the point of resistance or voltage drop in the circuit.

Cranking voltage test (battery to ground). This test determines the amount of voltage in the battery and electrical system during cranking.

To test the battery cranking voltage:

STEP 1 Attach the voltmeter test leads to the battery terminals (positive to positive and negative to negative). See Figure 13-13, Voltmeter 1.

STEP 2 Pull the coil wire from the distributor and ground it.

STEP 3 Crank the engine and observe the cranking voltage. The cranking voltage should be 9.6 volts or more.

Cranking voltage test (coil-to-ground). This test measures voltage at the coil during cranking.

STEP 1 Set the volt and ohm selector on the voltmeter to 16 V (see Figure 13-13, Voltmeter 2).

STEP 2 Connect the voltmeter NEG (–) lead to ground.

STEP 3 Connect the voltmeter POS (+) lead to the BAT (+) terminal on the coil.

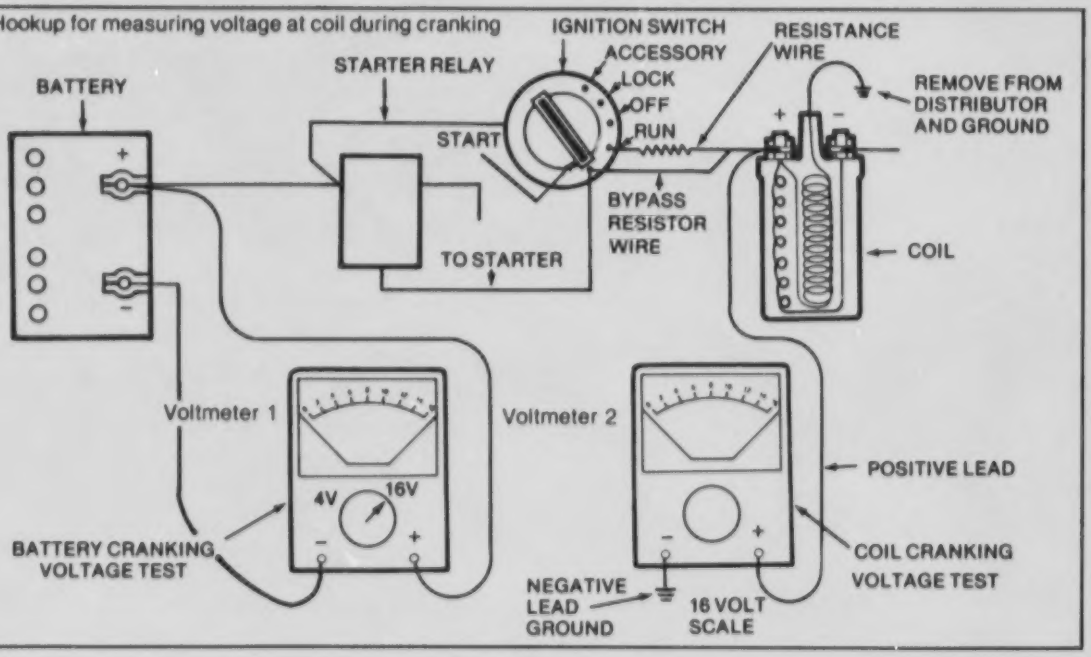
STEP 4 Ground the coil high-tension lead.

STEP 5 Have an assistant crank the engine from inside the vehicle, and record the voltmeter reading.

The reading is good if it is within .5 volt of the cranking voltage at the battery.

If the reading is not within this specification, there is too much resistance in the leads, switches, or connections between the coil and the battery.

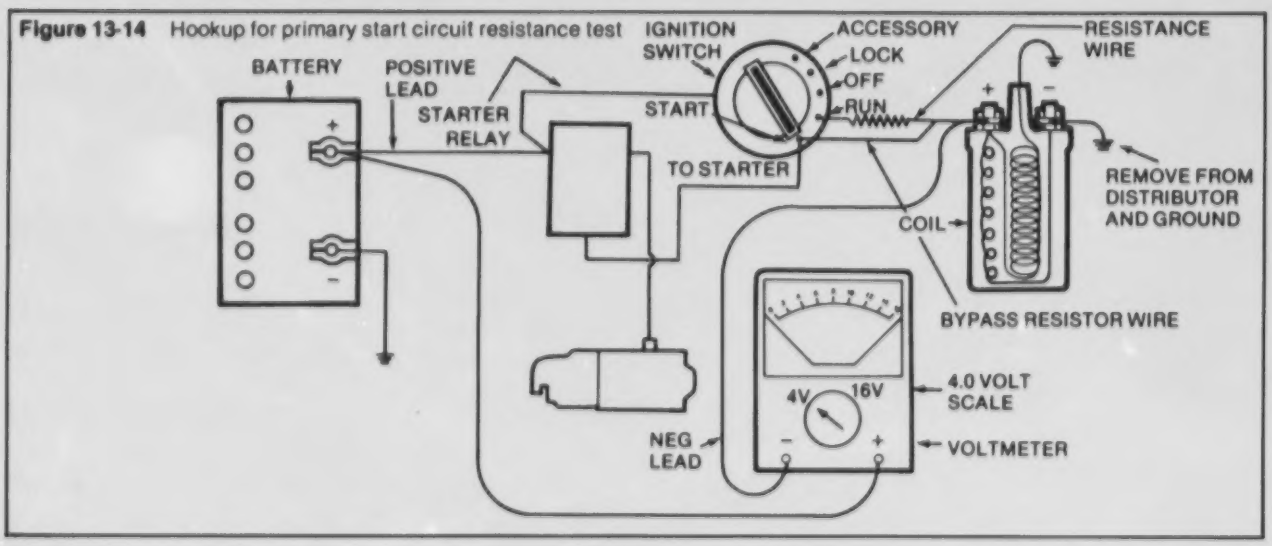
Figure 13-13 Hookup for measuring voltage at coil during cranking



Circuit resistance test (battery-to-coil). When voltage output is low, you must do the circuit resistance test to find the problem.

STEP 1 Set the volt and ohm selector to the 4 V scale, as shown in Figure 13-14.

Figure 13-14 Hookup for primary start circuit resistance test



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STEP 2 Connect the voltmeter POS (+) test lead to the battery cable on the positive battery post.

STEP 3 Connect the ground (black) voltmeter test lead to the BAT (+) terminal of the coil.

STEP 4 Remove the distributor primary lead from the coil terminal. With a jumper wire, ground the coil DIST terminal.

STEP 5 Have an assistant crank the engine from inside the vehicle, and record the voltmeter reading.

The reading is ***good*** if it is ***less*** than .5 volt.

The reading is ***bad*** if it is ***more*** than .5 volt. There is too much resistance (voltage drop) in the primary start circuit.

- To pinpoint the cause of the resistance, move the voltmeter POS (+) test lead to the next connecting point in the circuit (starter relay, relay-to-ignition switch, relay-to-coil, and bypass lead.)
- Have an assistant crank the engine, and repeat the test each time the voltmeter POS (+) test lead is moved to a different connecting point.
- Whenever the voltmeter reading ***drops*** (less than .5 volt), it means that the excessive circuit resistance is located in the last wire, electrical part, or connection that was checked.

  Maximum allowable circuit resistance is .3 volt at any switch or part, .2 volt in any lead or wire, and .0 volt at any connection.

Turn to your Review Exercise Book and complete Exercise 22.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

12. Using a voltmeter, test the voltage output of the primary start circuit (ground-to-coil). Write down the voltmeter reading. (pages 162-163)

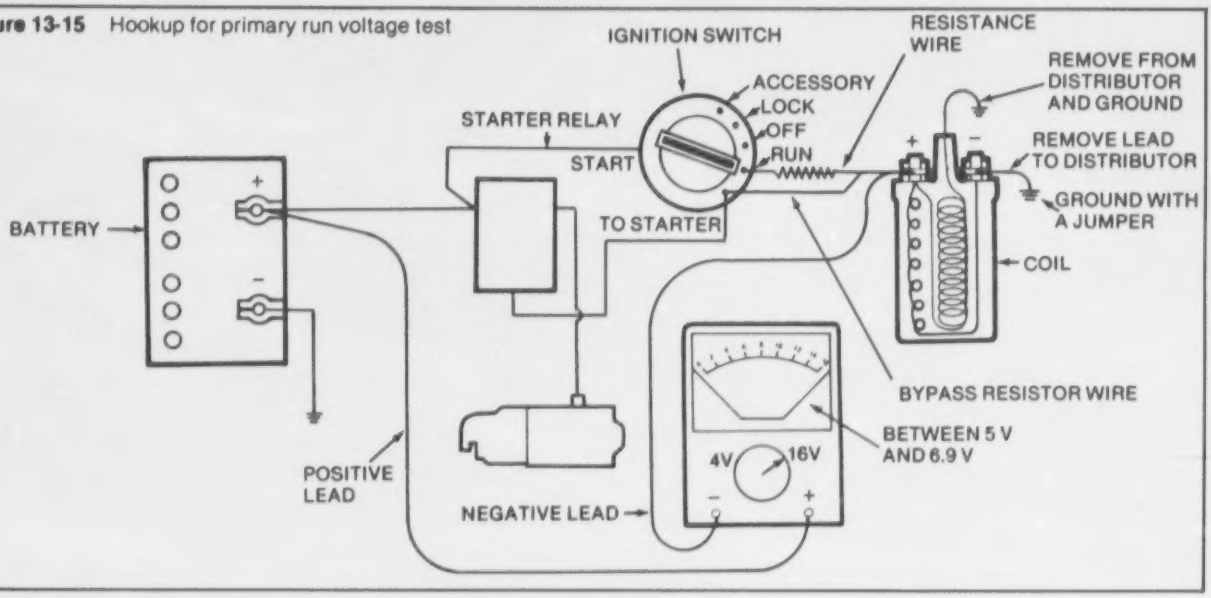
13. Using a voltmeter, test the primary start (battery-to-coil) circuit resistance. Write down the voltmeter reading. (pages 161-162) *Check your work with your instructor.*

After you have finished these activities, go on to the next section.

Primary Run Voltage Test (Battery-to-Coil)

The next few tests measure voltage and resistance in the primary circuit when the engine is running. It involves the following primary ignition parts: the starter relay connection, the hot lead to the ignition switch, the ignition switch and connector, and the resistance wire or ballast resistor. The tests are done with the ignition switch on *run* and all lights and accessories *off*.

Figure 13-15 Hookup for primary run voltage test



STEP 1 Connect the voltmeter POS (+) test lead to the battery cable on the positive battery post, as shown in Figure 13-15.

STEP 2 Connect the ground (black) voltmeter test lead to the BAT (+) terminal of the coil.

STEP 3 Remove the distributor primary lead from the coil terminal. With a jumper wire, ground the coil DIST terminal.

NOTE: You should notice, again, that the ignition switch is on *run*, as it is when the engine is operating. The voltage is flowing through the resistance wire, or in some cases, a ballast resistor to the coil.

STEP 4 Set the voltmeter on the 16 V scale.

STEP 5 Note the voltmeter reading. If the reading is between 5 and 6.9 volts, the ignition *run* circuit is okay.

If the reading is more than 6.9 volts, there is too much resistance. You will need to perform ignition switch and resistance wire tests, or ballast resistor tests.

To pinpoint which of the parts (ignition switch, resistance wire, or ballast resistor) is at fault, continue with the following tests:

Ignition switch test.

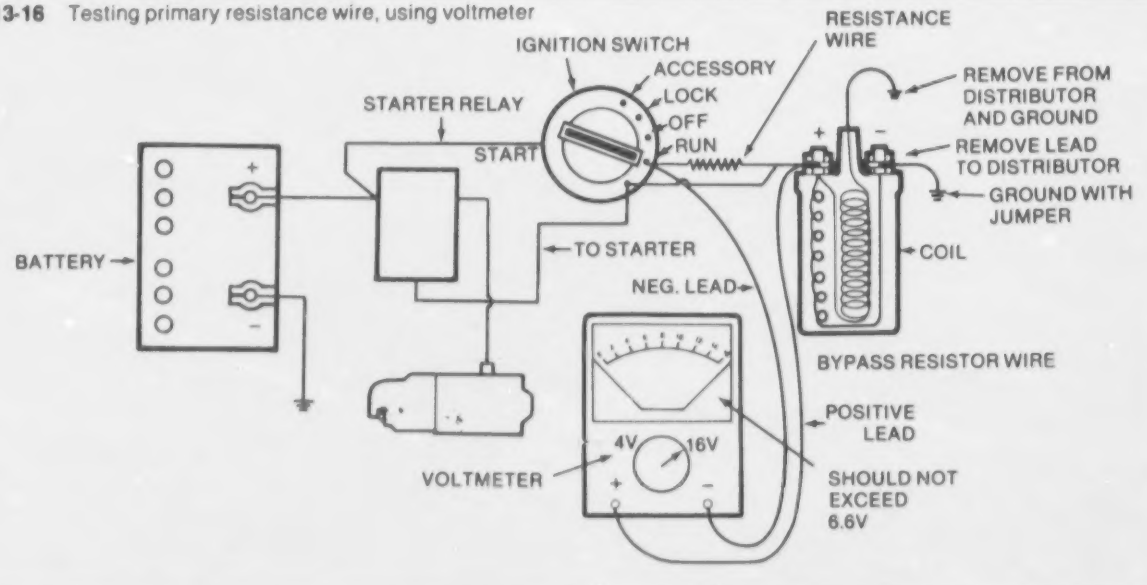
STEP 1 To check ignition switch contacts, turn the switch off and on a few times. If the switch contacts are okay, the readings will be the same each time the switch is turned on.

STEP 2 Check for loose connections by shaking the wires connected to the switch or the wire connector. The voltmeter needle should remain steady.

STEP 3 Crank the engine and check the voltmeter reading again. The voltmeter will read less than 1.0 volt if the ignition switch is okay. If the reading is higher, the ignition switch should be replaced.

Primary resistance wire tests. Special resistance wires used with 12-volt ignition systems are 5 to 6 feet long. They are contained in the regular wiring harness. As you learned in the introductory performance objective, the resistance wire is used in the primary circuit only when the ignition switch is on *run*. The purpose of the resistance wire is to control the current flow in the primary circuit as the vehicle goes various speeds.

Figure 13-16 Testing primary resistance wire, using voltmeter



TEST 1 Turn the ignition switch to *start*. If the engine fires when the ignition switch is turned to the start position, but stops when the switch is in the *run* position, it means that the resistance wire has lost its continuity. Or, it means that there is a bad connection.

If the wire is defective, it must be replaced, either by a ballast-type resistor or a new resistance wire.

TEST 2 When using a voltmeter, connect the tester's positive lead to the resistance wire terminal on the ignition switch. The negative test lead remains attached to the BAT (+) terminal of the coil. Turn the ignition switch on *run* (see Figure 13-16).

The reading is ***good*** if it does not exceed 6.6 volts.

The reading is ***bad*** if it is over 6.6 volts. This means the resistance wire should be replaced.

For accurate measurements of the amount of resistance that exists in a resistance wire, an ohmmeter is used. An ohmmeter measures resistance in ohms. Then, the results can be compared to the manufacturer's specifications (found in a technical service manual).

To make the test with an ohmmeter:

STEP 1 Turn off the ignition switch.

STEP 2 Remove the primary lead from the BAT (+) terminal of the coil. Connect one of the ohmmeter leads to the primary lead, as shown in Figure 13-17.

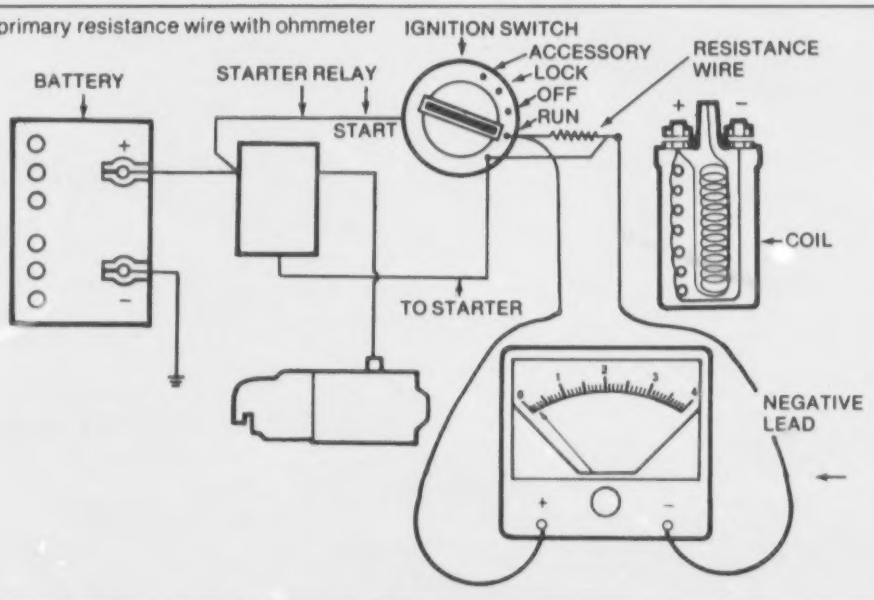


Figure 13-17 Testing primary resistance wire with ohmmeter

CAUTION: Be sure the resistor is completely disconnected from the circuit before testing.

STEP 3 Connect the other ohmmeter lead to the resistance wire terminal on the ignition switch.

STEP 4 Write down the reading in ohms.

STEP 5 Refer to the technical service manual for ignition resistor ohm specifications. You will see a table like this:

IGNITION COIL AND RESISTOR SPECIFICATIONS

YEAR	MODEL	—	—	Ignition Resistor Ohms at 75° F
AMERICAN MOTORS—ALL MODELS				
1969-74	6 cyl.	----	----	1.80
	V8 ②			1.35
	V8			1.35

②Delco-Remy

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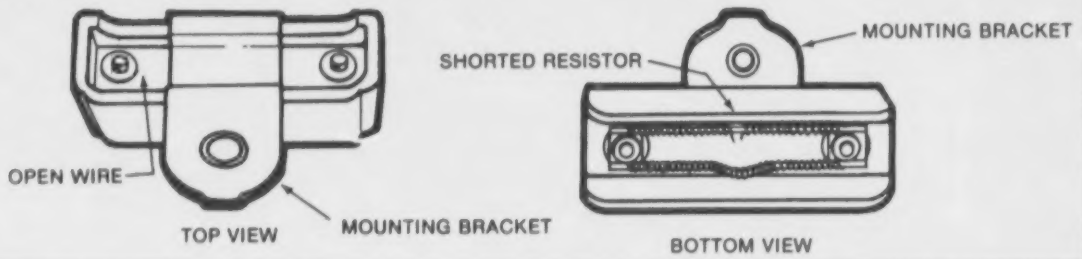
To find the listing for the vehicle you are testing, look for the name of the vehicle's manufacturer (or the make of the car). Under the name of the vehicle manufacturer (American Motors) in the left-hand column, you will find the year and the number of cylinders of the engine. For 1969-74 American Motors vehicles, 6-cylinders, the ignition resistor should be 1.80 ohms when the air temperature is 75° F. In other words, the resistor should be at room temperature when the resistance wire test is done.

The circled Number 2 that appears next to the engine type refers to the footnote at the bottom of the table. The footnote means that for a 1969-74, V-8 American Motors vehicle, the car uses a Delco-Remy resistor. For that resistor, resistance should be 1.35 ohms at 75° F.

If ohm resistance readings are higher or lower than those specified, the resistance wire or ballast resistor must be replaced.

Ballast resistor test. Some vehicles have a ballast-type resistor rather than a long resistance wire (see Figure 13-18).

Figure 13-18 Two types of ballast resistors



The ballast resistor is usually found at the coil end of the ignition wire. An ohmmeter must be used to measure the resistance of a ballast resistor.

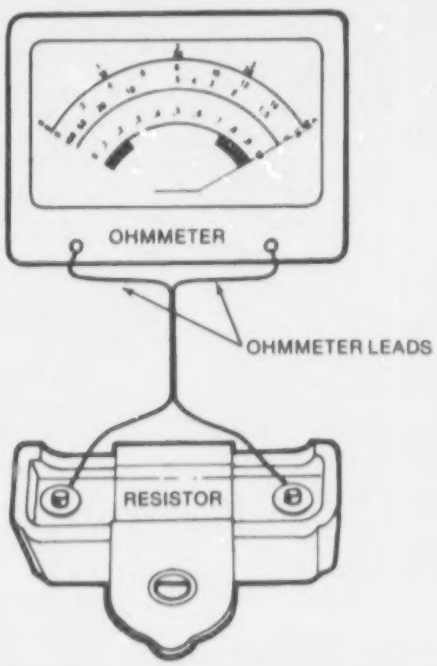
To make the ballast resistor test:

STEP 1 Disconnect the ignition wire from the ballast resistor.

CAUTION: Be sure the resistor is completely disconnected from the circuit before testing.

STEP 2 Attach one ohmmeter lead to the ignition wire terminal of the ballast resistor, as shown in Figure 13-19.

Figure 13-19 Using ohmmeter to check resistance in ballast resistor



STEP 3 Attach the other ohmmeter lead to the coil wire terminal of the ballast resistor.

STEP 4 Write down the reading in ohms.

STEP 5 Refer to the technical service manual for ignition resistor ohm specifications. Compare the results to these specifications.

Turn to your Review Exercise Book and complete Exercise 23.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

14. Using a voltmeter, test the primary run (battery-to-coil) circuit resistance. Write down the voltmeter reading. (pages 165-166)

15. Using a voltmeter, test the ignition switch contacts and lead connections. Write down the voltmeter readings. (page 166)

16. Using a voltmeter, test the resistance wire. Write down the voltmeter reading. (pages 166-168) *Check your work with your instructor.*

17. Using an ohmmeter, test a ballast resistor. Write down the ohmmeter reading and compare with manufacturer's specifications. (pages 168-169) *Check your work with your structor.*

After you have finished these activities, go on to the next section.

Coil Draw and Coil Resistance Tests

The coil draw test is done with an ammeter. The coil resistance test is done with an ohmmeter.

The coil is a transformer. It is used to change the battery's low voltage into the high voltage needed to fire the spark plugs (see Figure 13-20).

If there's a bad coil:

(1) the engine won't start

(2) the engine will stall when hot and won't start

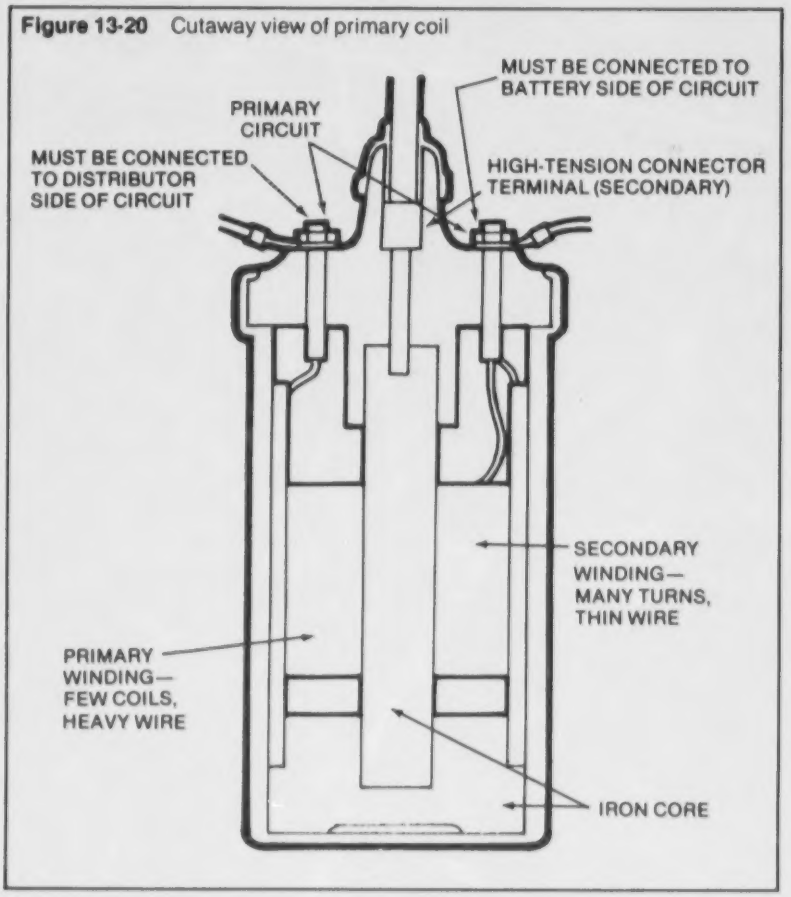
(3) the engine will miss or stumble under load

Coil draw test with an ammeter. This test is done with an ammeter to measure current flow in the primary ignition circuit. Improper current flow causes low coil output or contact point burning.

To test coil draw, make sure the engine is stopped, the ignition is on, and the contact points are closed.

STEP 1 Disconnect the coil-to-distributor primary lead.

Figure 13-20 Cutaway view of primary coil


MUST BE CONNECTED TO BATTERY SIDE OF CIRCUIT
PRIMARY CIRCUIT
MUST BE CONNECTED TO DISTRIBUTOR SIDE OF CIRCUIT
HIGH-TENSION CONNECTOR TERMINAL (SECONDARY)
SECONDARY WINDING— MANY TURNS, THIN WIRE
PRIMARY WINDING— FEW COILS, HEAVY WIRE
IRON CORE

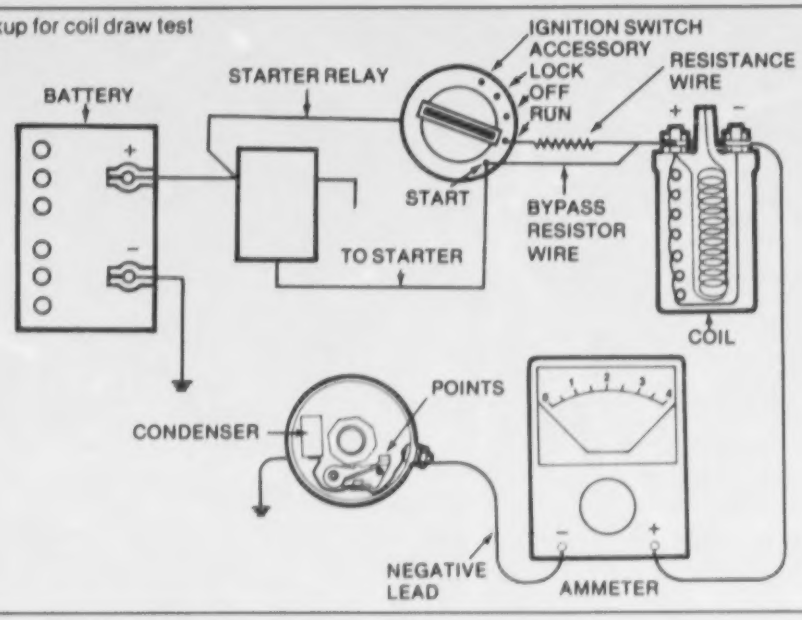
STEP 2 Connect ammeter test leads so all current in the circuit will flow through the tester. The POS (+) test lead attaches to the DIST (–) coil terminal. The NEG (–) test lead is connected to the coil-to-distributor lead, as shown in Figure 13-21. (It doesn't matter on some ammeters which lead connects to which part in the primary circuit. On these ammeters, the leads are not color-coded, since polarity doesn't matter.)

STEP 3 With the ignition on and the contact points closed, record the ammeter reading.

STEP 4 Now start the engine. With the engine operating at idling speed, record the ammeter reading.

STEP 5 Refer to the technical service manual and compare your test results to those given by the vehicle manufacturer. The specification table will look something like this:

Figure 13-21 Hookup for coil draw test



IGNITION COIL AND RESISTOR SPECIFICATIONS

YEAR	MODEL	COIL DRAW, AMPS. Engine Stopped	Engine Idling
AMERICAN MOTORS—All Models			
1969-74	6 cyl.	3.5	1.6
	V8 (2)	3.5	1.6
	V8	3.5	1.6

(2) Delco-Remy

Adapted from *Motor Auto Repair Manual*, 1975. 38th Edition. by permission © The Hearst Corporation.

The table specifies that for 1969-74, 6-cylinder American Motors vehicles, the coil draw with the engine stopped should read 3.5 amps. And, with the ***engine idling***, it should read 1.6 amps.

The reading is ***good*** if it matches specified ignition current with the engine both stopped and idling.

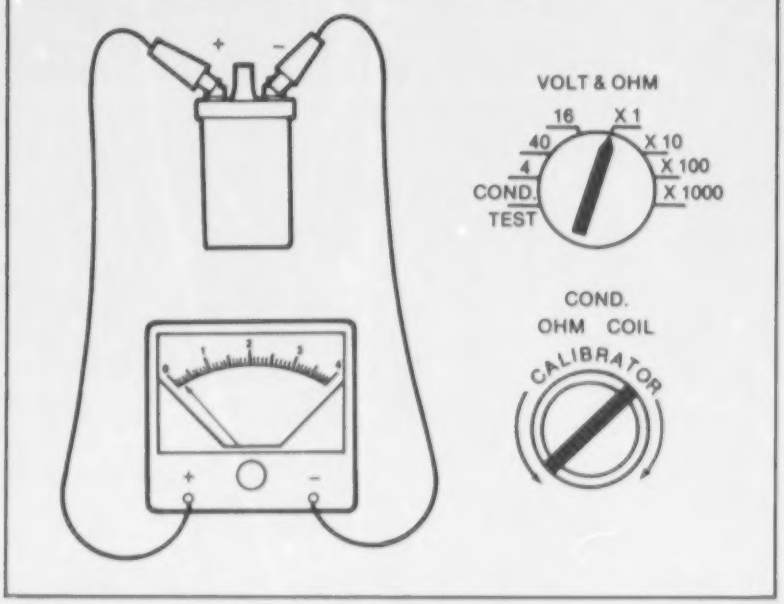
The reading is ***bad*** if it is lower than specified. This means there is too much resistance in the primary circuit parts, connections, or leads. If the reading is higher than specified, there is lower resistance than normal in the primary circuit parts.

Coil resistance test with an ohmmeter. This test is done with an ohmmeter to measure the amount of electrical resistance in the coil.

To test coil primary resistance; the ignition must be *off*, the primary ignition leads to the coil must be disconnected, and the room temperature should be 75°F.

STEP 1 Set the Volt and Ohm selector to the X 1. Calibrate the ohmmeter (see Figure 13-22).

Figure 13-22 Hookup for coil primary resistance test



STEP 2 Disconnect both primary ignition leads from the coil.

STEP 3 Connect the ohmmeter to the coil.

- Connect one test lead (either one) to the (+) terminal of the coil.
- Connect the other test lead to the (–) terminal.

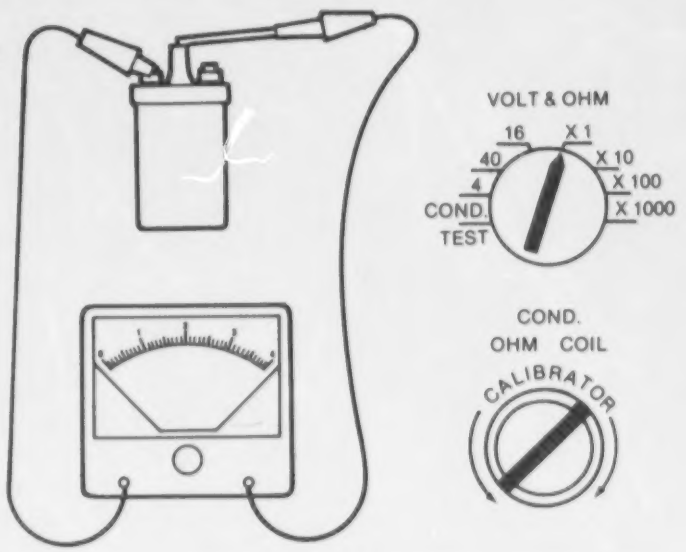
STEP 4 Read the ohmmeter and record the results.

To test coil secondary resistance, make sure the ignition is off, the coil high-tension lead is disconnected from the coil, the primary ignition leads to the coil are disconnected, and the room temperature is 75° F.

STEP 1 Set the Volt and Ohm selector to X 1000 (see Figure 13-23).

STEP 2 Connect either ohmmeter lead to EITHER primary terminal of the coil.

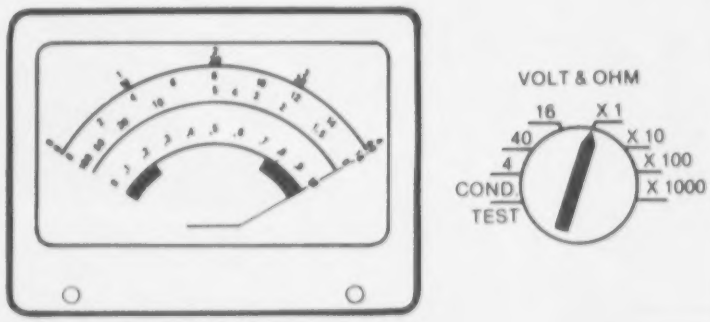
Figure 13-23 Hookup for coil secondary resistance test



STEP 3 Connect the other test lead to the center tower of the coil (with the grounding probe).

STEP 4 Read the ohmmeter scale from right to left on the middle scale (see Figure 13-24).

Figure 13-24 Ohmmeter scale and knob positions



STEP 5 When the selector knob is in the X 1 (times 1) position, read the scale directly to find the ohms resistance when the resistance is low (below 100 ohms).

STEP 6 In the X 10 (times 10) position, read the scale and add one zero to the reading. For example, 5 becomes 50 ohms. This scale reads up to 1,000 ohms. In the X 100

(times 100) position, read the scale and add two zeros to the reading. For example, 5 becomes 500 ohms. This scale reads up to 10,000 ohms. In the X 1000 (times 1,000) position, read the scale and add three zeros to the reading. For example, 5 becomes 5,000 ohms. This scale reads up to 100,000 ohms.

Refer to the technical service manual and compare the test results to those given by the vehicle manufacturer. The specification table will look something like this:

IGNITION COIL AND RESISTOR SPECIFICATIONS

YEAR	MODEL	COIL DRAW, AMPS		COIL RESISTANCE, OHMS	
		Engine Stopped	Engine Idling	Primary @75°F	Secondary @75°F
AMERICAN MOTORS—All Models					
		COIL DRAW, AMPS		COIL RESISTANCE, OHMS	
				PRIMARY	SECONDARY
1969-74	6 cyl.			1.40-1.65	3000-20,000
	V8②			1.77-2.05	3000-20,000
	V8			1.64-1.80	9300-11,800

②Delco-Remy

Adapted from *Motor Auto Repair Manual*, 1975, 38th Edition, by permission © The Hearst Corporation.

The table tells us that for a 1969-74, 6-cylinder American Motors vehicle, the primary coil resistance should be between 1.40 and 1.65 ohms. Also, it tells you that the coil's secondary resistance should be between 3,000 and 20,000 ohms.

Resistance is *good* when it is within manufacturer's specifications when the coil is at room temperature.

Resistance is *bad* when it is higher or lower than specified. This means there is an incorrect or damaged coil and the coil should be replaced.

Turn to your Review Exercise Book and complete Exercise 24.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

18. Using an ammeter, test the coil draw with the engine stopped and with the engine idling. Write down the ammeter readings and compare with the vehicle manufacturer's specifications. (pages 170-172) *Check your work with your instructor.*

19. Using an ohmmeter, test both the coil primary and secondary resistance. Write down the ohmmeter readings. Compare them with the vehicle manufacturer's specifications. (pages 172-175) *Check your work with your instructor.*

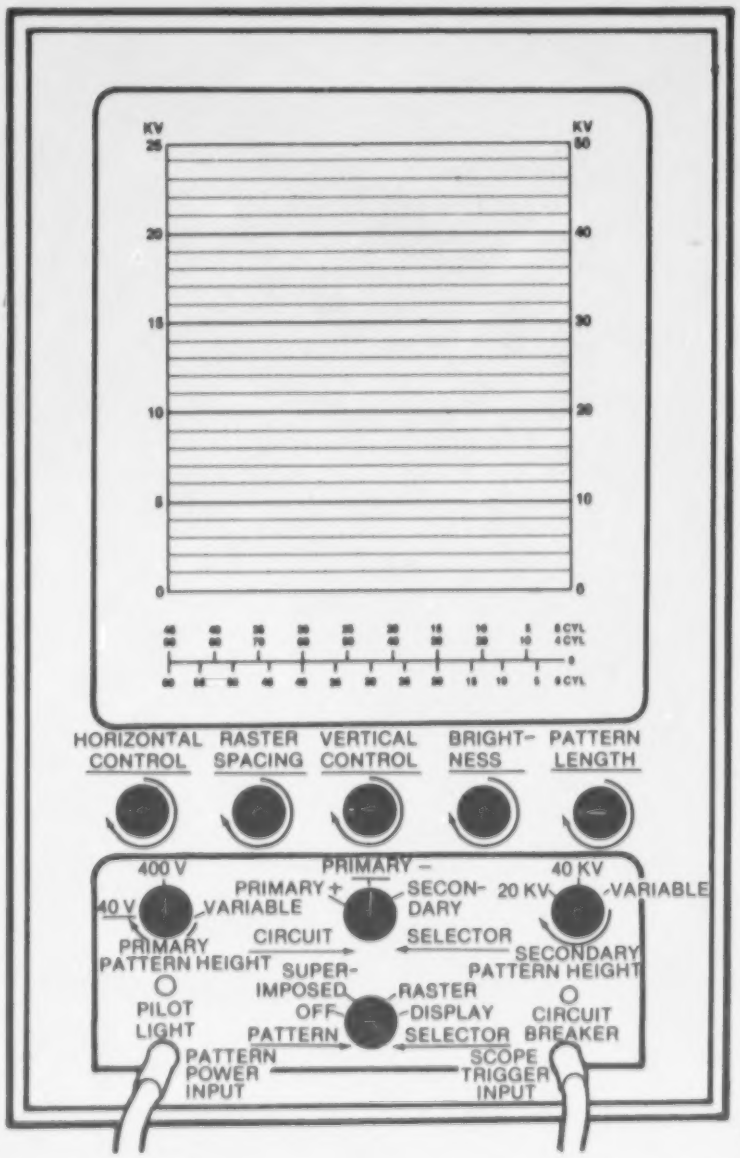
After you have finished these activities, go on to the next section.

TESTING THE PRIMARY IGNITION CIRCUIT WITH AN OSCILLOSCOPE

Purpose and Function of the Scope

The engine oscilloscope is an ignition testing instrument. The oscilloscope is commonly called a scope.

Figure 13-25 Engine oscilloscope



From Sun Electric Corporation. Used with permission of Sun Electric Corporation.

The scope is a voltmeter and is highly sensitive to voltage variations in an ignition system (see Figure 13-25). The difference between a scope and a voltmeter is that voltage on the scope is viewed in the form of a line appearing on a TV-like screen, while the voltmeter uses a meter.

Figure 13-26 Oscilloscope waveform or trace

The scope line that appears on the TV-like screen shows the voltage and how it changes (up, down, wiggles, or oscillations) during a period of time. This line is called a waveform, or trace (see Figure 13-26). The ignition system itself will determine the shape of the waveform, because the overall pattern or form represents the way the ignition system operates.

The secret for using the scope correctly is to learn what different voltage waveforms mean.

The Scope Screen

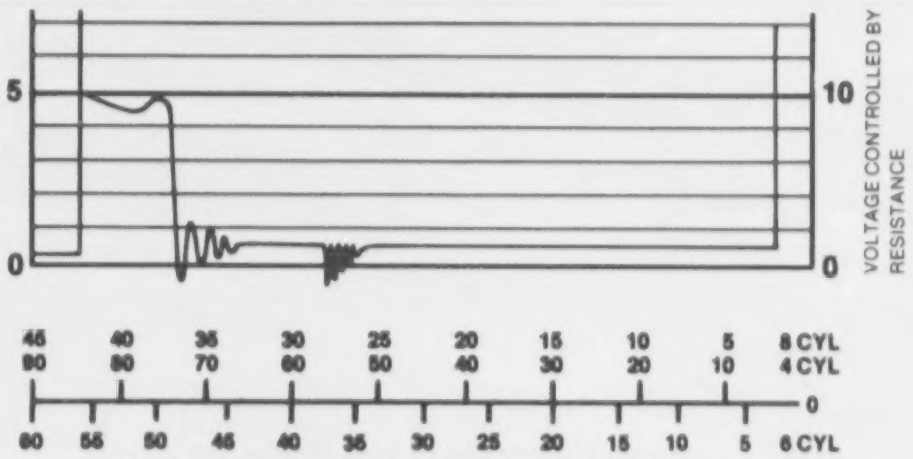
The scope screen shows a picture of *voltage* in relation to *time*.

The amount of voltage is indicated by the height of the waveform, as shown in Figure 13-27. Readings are in kilovolts (KV), as marked along the sides of the scope screen. (One kilovolt equals 1,000 volts.)

The time is indicated by the movement of the waveform across the screen. (Readings are in degrees of distributor cam rotation, or dwell time.) Note the scales on the bottom of the screen. These are dwell scales for 8-cylinder, 4-cylinder, and 6-cylinder engines. The scales are read from right to left.

You'll learn how to read the waveform on the scope screen later in this performance objective.

Figure 13-27 Scope waveform indicates amount of voltage



From *The Automotive Oscilloscope*, by N. W. Whited. ©1972 Delmar Publishers. Used with permission of Delmar Publishers.

Setting the Scope Controls

Before you use a scope, you need to make a few adjustments of the controls. Some of the controls on a scope are not used every time the scope is used, once they are adjusted. Always remember to follow the scope manufacturer's recommended procedures for making these adjustments:

(1) Turn the tester AC (alternating current) switch on.

(2) Turn the ***pattern selector*** knob to the display position. (The pilot light should be on.)

(3) Turn the ***circuit selector*** knob to the secondary position.

(4) Turn the ***secondary pattern height*** knob to the 40 KV position. (This knob controls the vertical size of secondary patterns.) When in the 40 KV position, read the scale on the right side of the screen. When in the 20 KV position, read the scale on the left side of the screen.

The ***primary pattern height*** knob lets you control the size of the primary pattern. (You would use this control when the ***circuit selector*** knob is turned to the primary position.) When in the 400-volt position, you read the scale on the right side of the screen. (Because the scale only goes from 0 to 40, you have to add a zero when reading the scale.) When in the 40-volt position, you read the number directly.

(5) Turn the ***brightness control*** knob until a bright pattern line appears. (This knob controls brillance of the pattern.)

(6) Adjust the ***verticle control*** knob until the pattern is on the zero line or 0 KV line. This line is a straight line and is also called the base line of the screen. (This knob controls the verticle position of the pattern. That is, it raises or lowers the pattern on the screen.)

(7) Turn the ***horizontal control*** knob until the left end of the pattern is on the left margin line. (This knob controls the horizontal position of the pattern.)

(8) Turn the ***pattern length*** knob until the right end of the pattern is on the right margin line. (This knob controls the horizontal length of the pattern.)

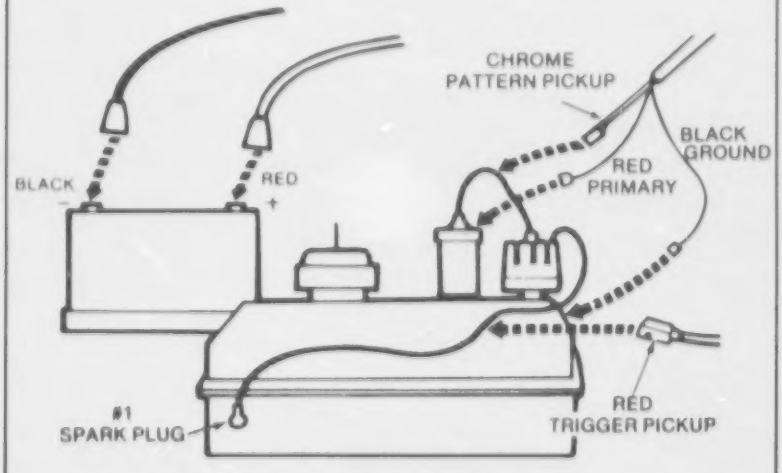
If the scope you have is not the same as the one illustrated here, ask your instructor for the scope booklet. Study the controls, the location of each control, and the scope adjustment procedures.

Scope Hookup to Engine

For all scopes, always follow the manufacturer's instructions for proper engine connections. Later model scopes use INDUCTIVE pickup clamps that circle the ignition leads. The attachment of these clamps does not require you to disconnect the ignition leads.

To hook up scope to engine (see Figure 13-28):

Figure 13-28 Scope hookup for testing the engine primary circuit



Adapted from the *Sun Engine Performance Handbook. Operating Instructions for the Sun Infra-Red Engine Performance Tester. Model 945/947.* Used with permission of Sun Electric Corporation.

STEP 1 Clamp the chrome pattern pickup around the coil high-tension wire after disconnecting this wire from the distributor cap.

STEP 2 Connect the red primary tester lead to the DIST (–) terminal of the coil.

STEP 3 Connect the black primary ground tester lead to a good ground on the engine block.

STEP 4 Clamp the red trigger pickup around the #1 spark plug wire, near the distributor cap.

STEP 5 Connect the tester battery leads to the battery terminals. The red positive lead is connected to the POS (+) battery terminal.

STEP 6 Connect the black negative lead to the NEG (–) battery terminal.

Turn to your Review Exercise Book and complete Exercise 25.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

20. Set the scope controls according to the scope manufacturer's procedures. (pages 177-180)

21. Connect the scope test leads to the engine. (pages 180-181)

After you have finished these activities, go on to the next section.

Waveform Patterns

Before starting the engine, you need to learn about the shapes of the patterns you'll be looking at. The shape of the pattern shows what is happening in the ignition system.

The secondary waveform pattern is more commonly used than the primary waveform pattern when diagnosing ignition troubles. Therefore, we will study the secondary pattern.

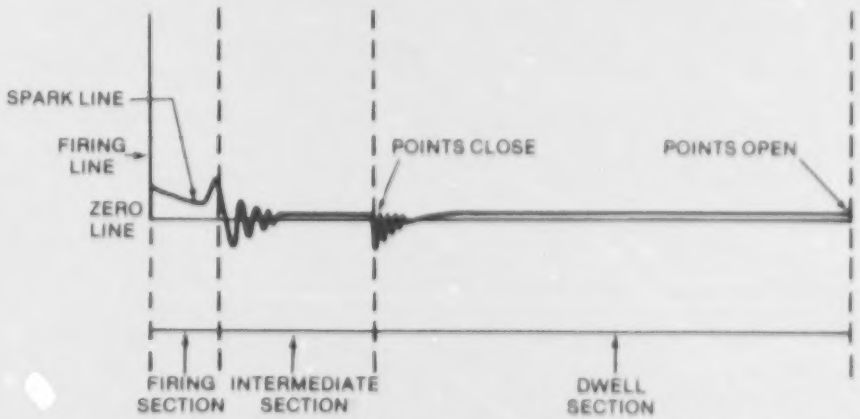
A standard secondary ignition pattern for a properly operating ignition system looks like Figure 13-29. This pattern shows what happens in the ignition system when one cylinder is fired in an engine. To find ignition problems, look at the part of the pattern that differs from the normal one shown. This will help you to identify and locate the parts of the ignition system that are not working as they should.

Figure 13-29 Standard secondary ignition pattern

From *A Sun Performance Prover, Model TUT-915-R, Tune-Up Tester, Operating Instructions*. Used with permission of Sun Electric Corporation.

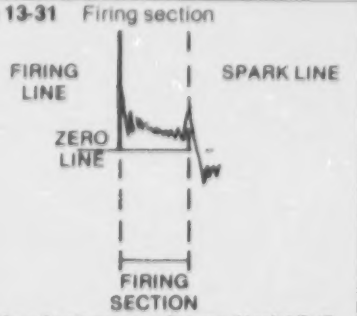
The secondary pattern is divided into three parts (see Figure 13-30): the firing section, the intermediate section, and the dwell section. During a scope test, you'll look at each of these sections and will compare them to a good or normal pattern.

Figure 13-30 Three sections of waveform or pattern: firing, intermediate, and dwell



From *A Sun Performance Prover, Model TUT-915-R, Tune-Up Tester, Operating Instructions*. Used with permission of Sun Electric Corporation.

Figure 13-31 Firing section



From *A Sun Performance Prover, Model TUT-915-R, Tune-Up Tester, Operating Instructions*. Used with permission of Sun Electric Corporation.

Firing section. The firing section consists of the *firing line*, which shows the voltage needed to fire the spark plug; and the *spark line*, which shows the changes in voltage that occur as the plug arcs.

At the end of the spark line the arcing at the plug has stopped (see Figure 13-31). The firing section shows defects in plugs, wires, the cap, the rotor, and the engine (conditions that affect plug firing).

Intermediate section. The intermediate section is a series of waves that change into a straight line, as shown in Figure 13-32.

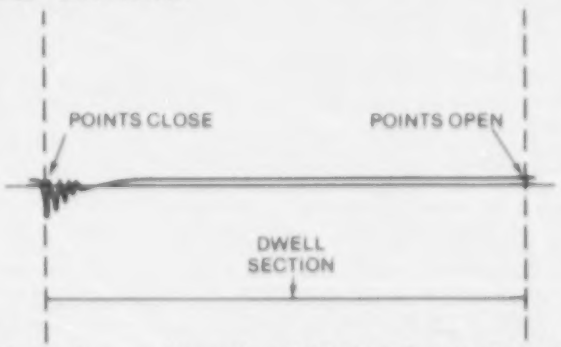
Figure 13-32 Intermediate section

From *A Sun Performance Prover, Model TUT-915-R, Tune-Up Tester, Operating Instructions.* Used with permission of Sun Electric Corporation.

This wavy line shows how the coil and the condenser use up the continuing electrical current in the ignition circuit after the arcing at the plug has stopped. The intermediate section shows defects in the coil, condenser, and primary circuit.

Dwell section. The dwell section begins when the contact points close. At that point, the pattern drops, followed by waves (oscillations) that taper off to a straight line, as shown in Figure 13-33. At the end of the dwell period, when the points open to start a new cycle, the pattern turns sharply upward. This section shows defects in poor contact points (dirty, burned, misaligned, and weak point tension), pitted points, and arcing from poor condenser action.

Figure 13-33 Dwell section

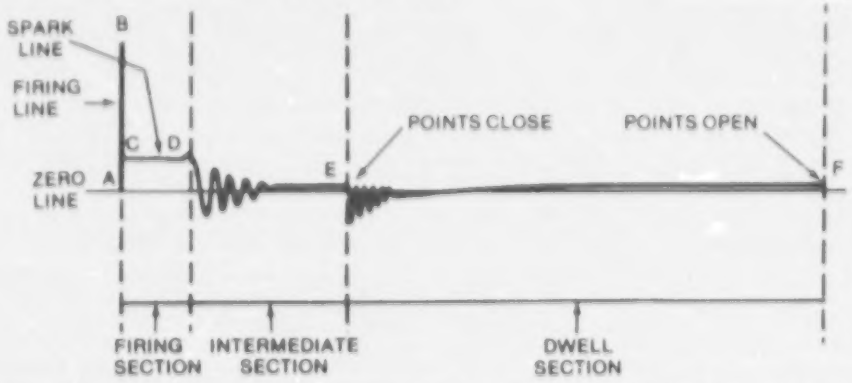


From *A Sun Performance Prover, Model TUT-915-R, Tune-Up Tester, Operating Instructions.* Used with permission of Sun Electric Corporation.

To review the order of ignition events, look at Figure 13-34 and read the following information.

(1) At Point A (see Figure 13-34), the points open and the plug fires.

Figure 13-34 Scope pattern for sequence of ignition events



From *A Sun Performance Prover, Model TUT-915-R, Tune-Up Tester, Operating Instructions.* Used with permission of Sun Electric Corporation.

(2) The height of Point B shows the number of volts needed to fire this particular plug.

(3) From Point C to Point D, the electricity is flowing across the plug electrodes.

(4) At Point D, the available voltage can no longer overcome the resistance of the rotor and plug gap. As a result, the plug stops firing.

(5) From Point D to Point E, the continuing electric current oscillates through the ignition circuit and dies out, before the points close.

(6) At Point E, the points close. The coil begins to saturate in order to fire the next plug when the points open at Points F-A.

Each pattern section, then, is directly related to the ignition parts that are affected during the ignition cycle.

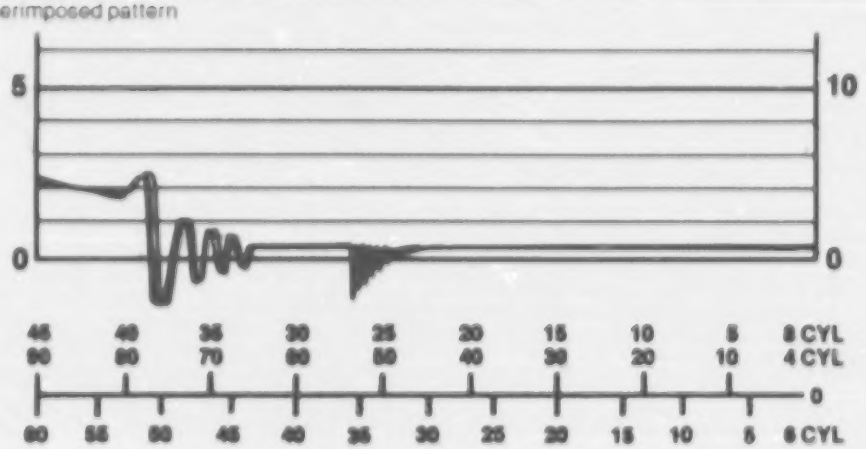
Scope Pattern Selections

There are three types of patterns that may be selected in the secondary circuit selection to appear on the scope screen. They are ***superimposed***, ***display***, and ***raster***. Not all scopes are equipped to select all three patterns.

On the primary circuit selection, only two of the patterns may be selected: ***superimposed*** and ***raster***.

The ***superimposed*** pattern shows the individual waveforms of each ignition cycle (or each cylinder) on top of each other, as shown in Figure 13-35. For example, on an 8-cylinder engine, instead of just one waveform appearing on the screen, all eight waveforms will appear together, one on top of the other.

Figure 13-35 Superimposed pattern

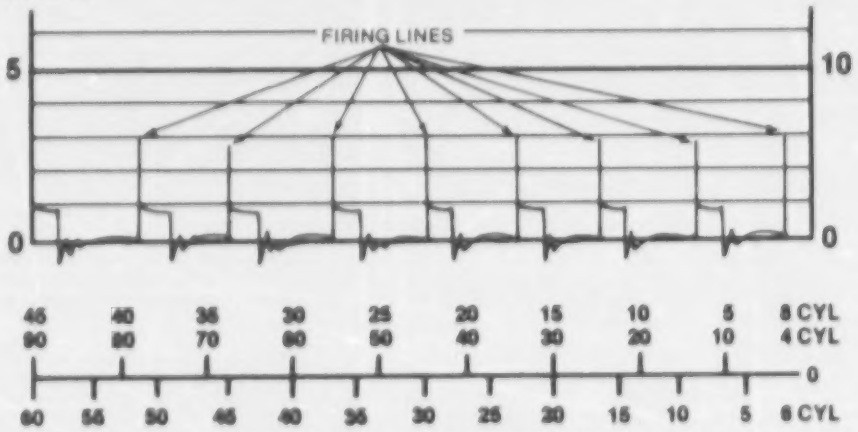


From *The Automotive Oscilloscope*, by N. W. Whited. ©1972 Delmar Publishers. Used with permission of Delmar Publishers.

The superimposed pattern is used to check the uniformity (evenness) of the individual cycles. Cycles will never be perfect but they must be the same within certain limitations.

The second type of pattern is the *display pattern*, shown in Figure 13-36. In this pattern, all the ignition cycles or waveforms are shown side by side. It is often called a parade pattern. If you will count the number of firing lines shown in Figure 13-36, you will notice that this is a display pattern of an 8-cylinder engine.

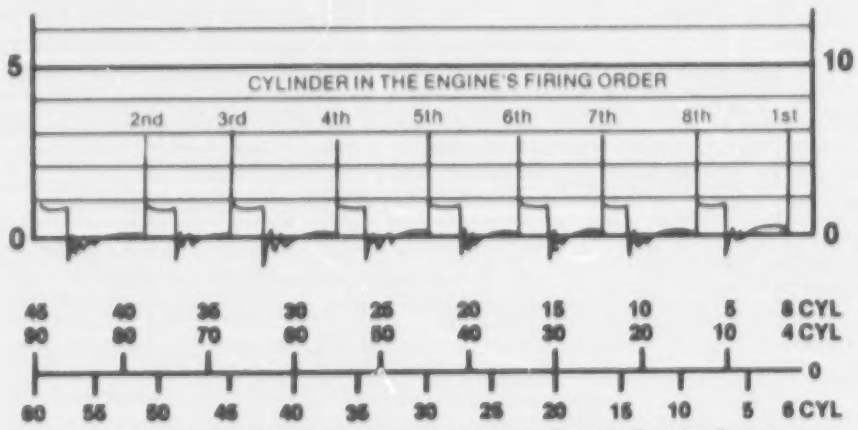
Figure 13-36 Display pattern



From *The Automotive Oscilloscope*, by N. W. Whited. ©1972 Delmar Publishers. Used with permission of Delmar Publishers.

When the pattern trigger pickup is connected around the lead of the #1 spark plug, the pattern will be displayed in the firing order of the engine.

Figure 13-37 Firing order display pattern



From the *Equipment Operating Instruction Manual—Tune-Up Training Course*. Used with permission of Sun Electric Corporation.

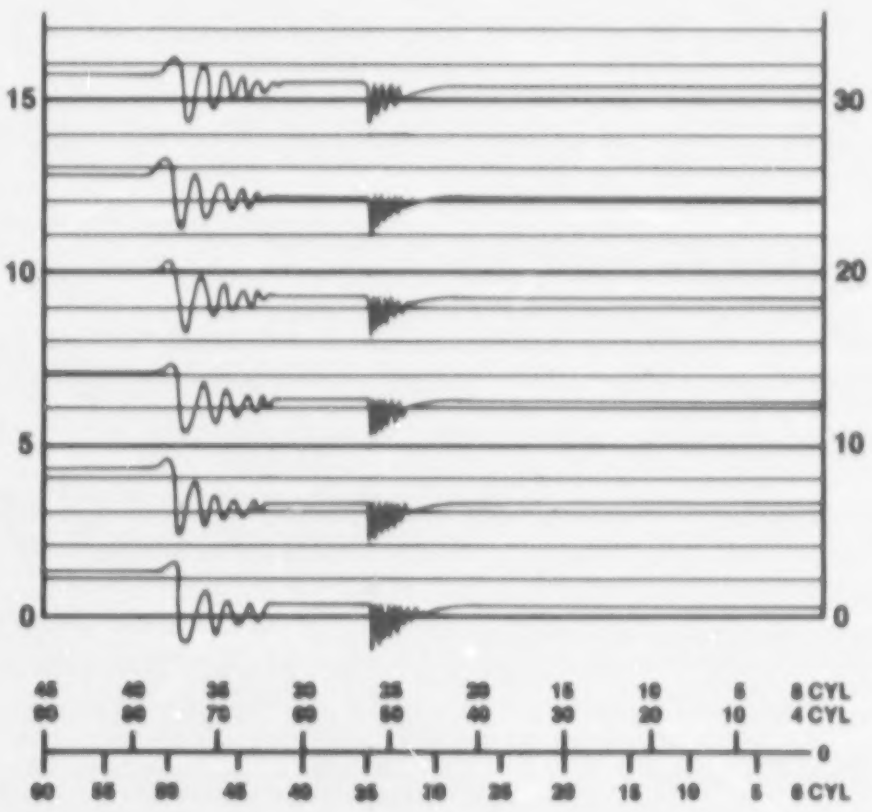
Because the pattern is triggered by the firing of the #1 spark plug, the firing line of Spark Plug #1 will be at the extreme right, as shown in Figure 13-37. The spark line of Spark Plug #1 will be at the left.

Therefore, the firing order of the engine starts at the extreme right. On the left of the screen, the second, third, fourth, fifth, sixth, seventh, and eighth cylinders are shown.

The display pattern allows you to pick out the cylinder where an ignition problem exists, because you can compare the ignition cycles of each cylinder. It is especially important to compare the amount of firing voltage of each spark plug.

A third type of pattern is called the ***raster pattern*** (see Figure 13-38).

Figure 13-38 Raster pattern

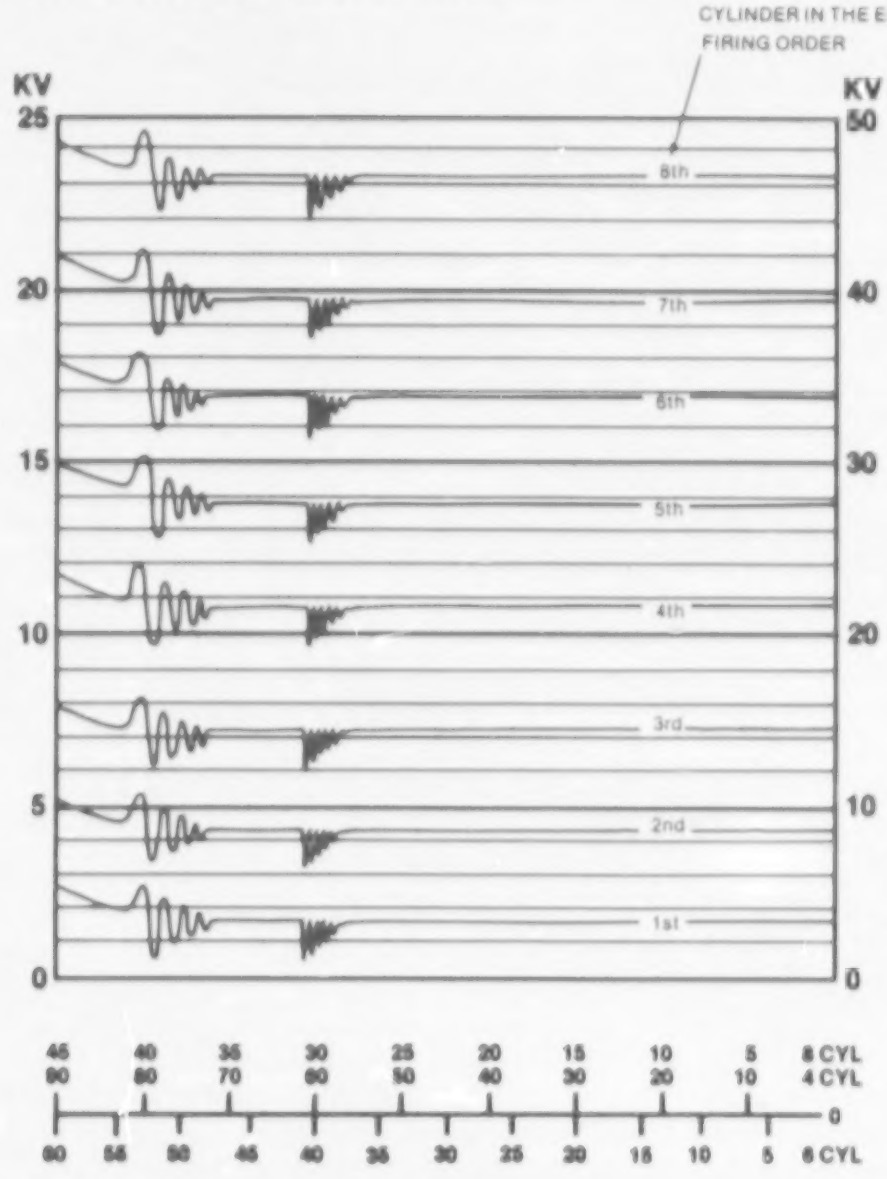


From *The Automotive Oscilloscope*, by N. W. Whited. ©1972 Delmar Publishers. Used with permission of Delmar Publishers.

Notice there are six waveforms. This means the pattern is for a 6-cylinder engine.

In this pattern the ignition cycles (waveforms) are stacked one above the other. It allows a close comparison of ignition cycles of each cylinder.

Figure 13-39 Firing order of raster pattern begins at bottom of screen



From the *Equipment Operating Instruction Manual—Tune-Up Training Course.* Used with permission of Sun Electric Corporation.

In the raster pattern, the engine firing order begins at the bottom of the screen. The ignition cycle of the #1 spark plug or #1 cylinder appears at the bottom. Then, the patterns of the next cylinders to follow in the engine's firing order are arranged one over the other.

Turn to your Review Exercise Book and complete Exercise 26.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

22. Practice drawing the secondary scope patterns. Identify the ignition events on the patterns. (pages 181-184) *Check your work with your instructor.*

23. Start the engine and operate the scope on the secondary circuit. Adjust the scope, change the pattern selections, and practice reading the three sections of the pattern. (pages 184-188) *Check your work with your instructor.*

After you have finished these activities, go on to the next section.

Scope Primary Ignition Tests

A scope is used to look at the patterns of both the primary and secondary circuits of an ignition system. In the following tests, which involve the primary ignition circuit, the secondary waveform is the most informative. It is the one you'll be working with most of the time. However, when greater clarity is needed, particularly in measuring point dwell, the primary waveform will be more useful.

Cranking coil output test. The purpose of the coil output test is to find out quickly, in the very beginning, if the primary circuit or coil is at fault. You will do this by measuring the secondary voltage available to fire the spark plug. Remember, you can't get any more out of the coil than you put into it.

STEP 1 Turn the ***circuit selector*** knob to the secondary circuit. (The high-tension coil wire was removed from the center tower of the distributor cap when you connected the scope test leads to the engine.)

STEP 2 Turn the ***pattern selector*** to the ***display*** position.

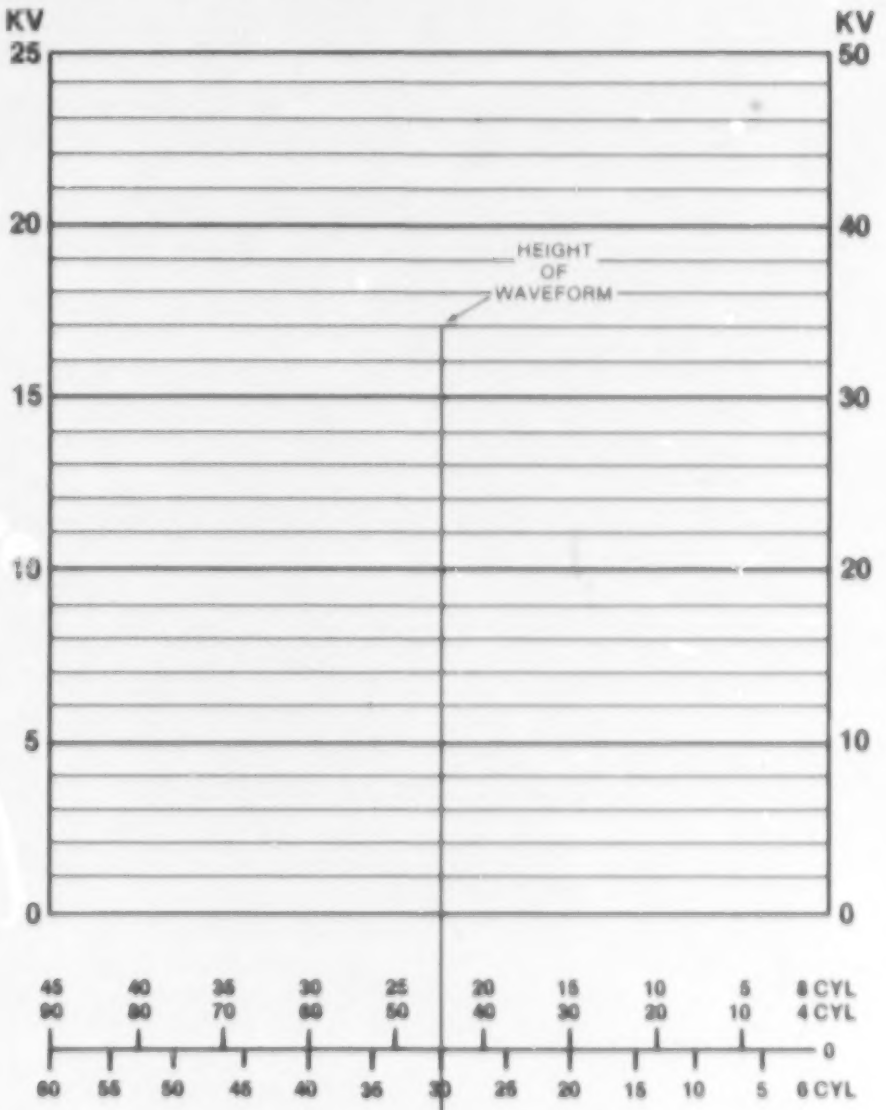
STEP 3 Turn the ***secondary pattern height*** knob to the 40 KV position.

STEP 4 If necessary, align the pattern to the zero line.

STEP 5 With the ignition switch on, crank the engine.

STEP 6 Look at the height of the waveform for available voltage (see Figure 13-40).

Figure 13-40 Display pattern for cranking coil output test



From the *Sun Engine Performance Handbook. Operating Instructions for the Sun Infra-Red Engine Performance Tester. Model 945/947.* Used with permission of Sun Electric Corporation.

The pattern is *good* if the height is more than 20 KV on the 40 KV height scale.

If highest part of the trace is not more than 20 KV, then the battery is low, the ignition circuit is bad, the resistor bypass circuit is bad, dwell is insufficient, distributor resistance is excessive, or the coil or condenser is bad.

STEP 7 Reinstall the high-tension coil wire into the center tower of the distributor cap.

Reversed polarity test. The result of a coil or battery connected to the ignition circuit in reverse polarity is that 20-40 percent more voltage is required to fire the spark plugs. To find out if the primary circuit has reverse polarity, do the following steps.

STEP 1 If the scope has a polarity switch, put the switch in the position that matches the polarity of the vehicle.

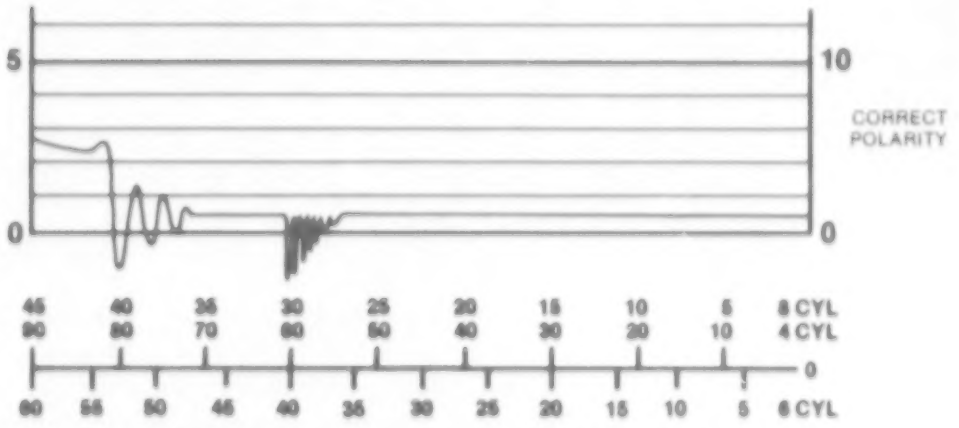
STEP 2 Start the engine and adjust the speed to idle RPM.

STEP 3 Turn the ***pattern selector*** knob to the ***raster*** position. (You can also use the superimposed position.)

STEP 4 Adjust the pattern length to align with the vertical lines on the scope screen.

STEP 5 Look at the pattern. The pattern should be right side up.

Figure 13-41 Raster pattern showing correct coil polarity



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The pattern is ***good*** if the firing line goes up and the point closing lines go down as shown in Figure 13-41.

The pattern is ***bad*** if it is upside down, as shown in Figure 13-42. This means that the battery polarity is reversed, the coil is improperly connected, or the coil is the wrong one for the vehicle.

Figure 13-42 Raster pattern showing reversed polarity

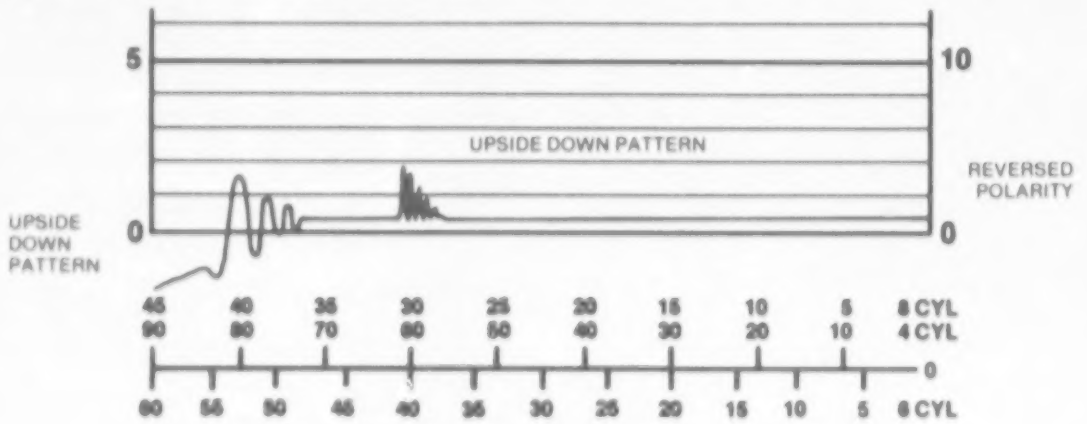

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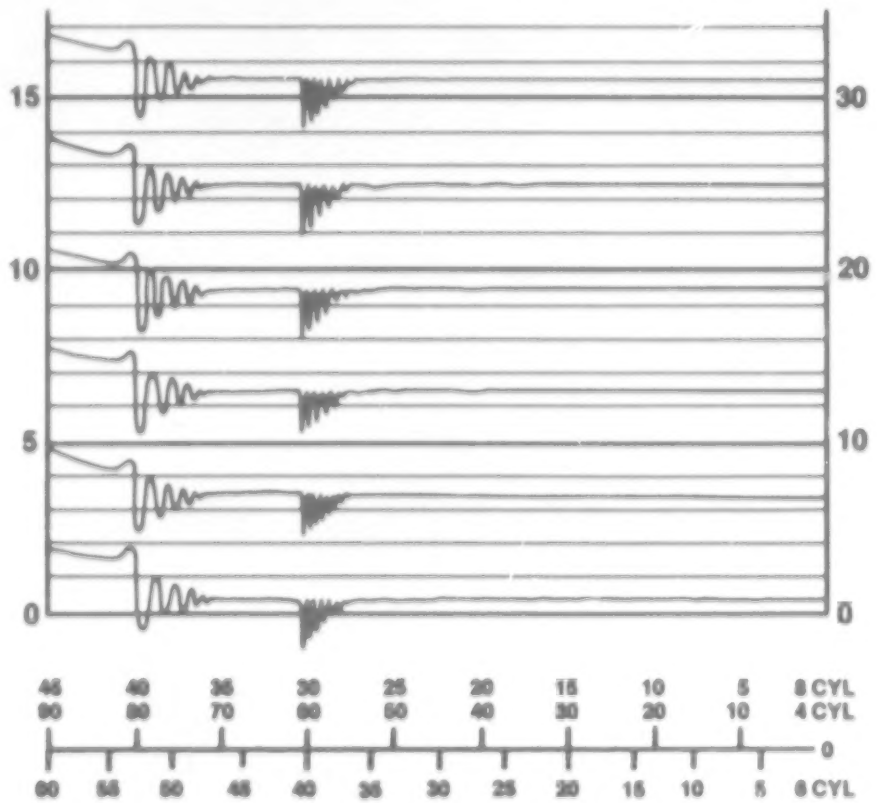
Figure 13-43 Normal raster secondary pattern for testing for loose primary lead



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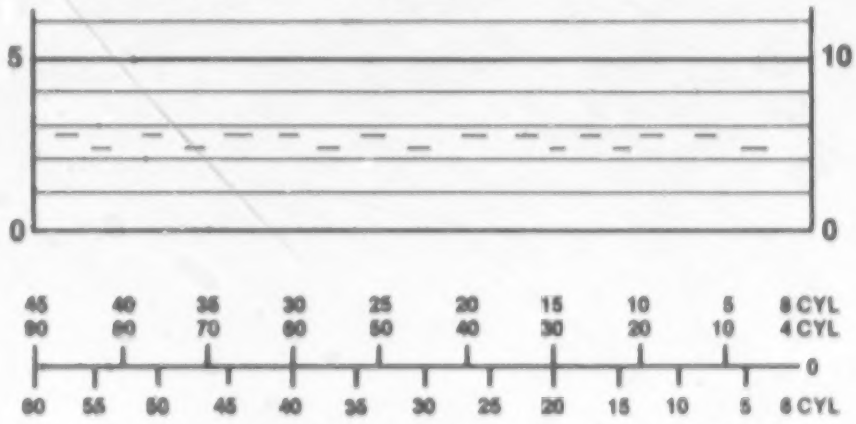
Loose primary lead test. With the pattern selector knob turned to the ***raster*** position and with the engine idling, look at the pattern on the screen (see Figure 13-43).

The lead is not loose if the secondary pattern is normal (see Figure 13-43).

Figure 13-44 No pattern, indicating loose or disconnected primary lead



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The lead is loose if there is no pattern (see Figure 13-44). This means that the primary pickup on the engine is loose, or that a primary lead is loose or disconnected from the coil.

Loose primary connection test. With the engine idling and the scope controls on the secondary circuit and on the ***raster*** position, test for loose or corroded connections in the primary circuit.

The primary circuit connection is ***good*** if the secondary pattern is normal, as shown in Figure 13-45.

The primary circuit connection is ***bad*** if the pattern shows short spikes in the dwell period (see Figure 13-46). The loose connection in the primary circuit can be anywhere between the battery and the points.

The primary circuit connection is also ***bad*** if the pattern shows a rippled dwell line, as shown in Figure 13-47. This pattern means that a corroded connection exists in the primary circuit.

Figure 13-45 Normal secondary pattern: no loose or corroded connections

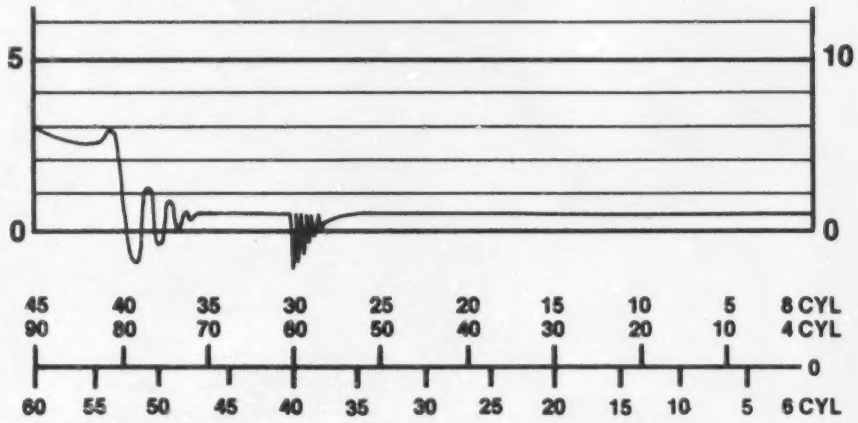

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Figure 13-46 Short spikes indicate a loose connection in the primary circuit

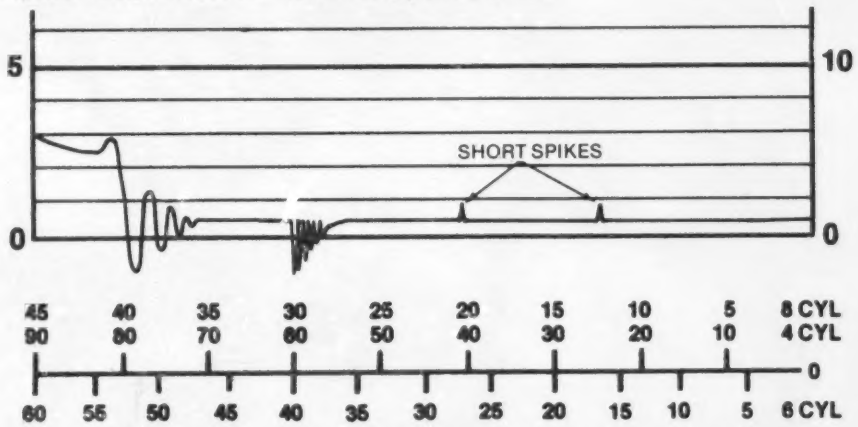

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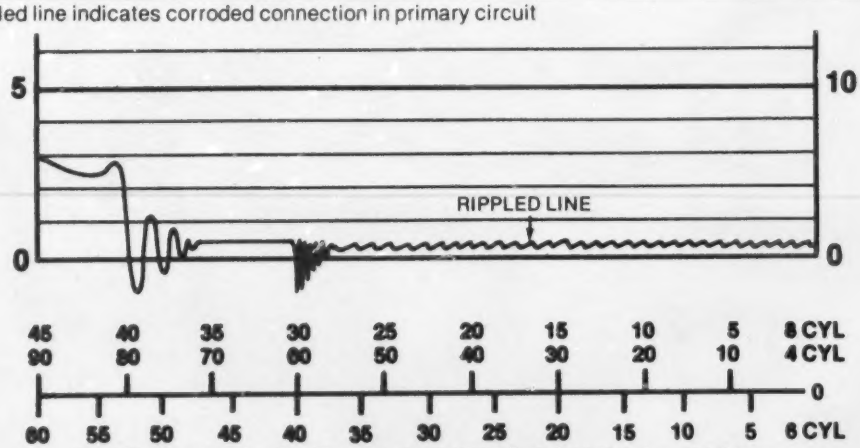
Figure 13-47 Rippled line indicates corroded connection in primary circuit



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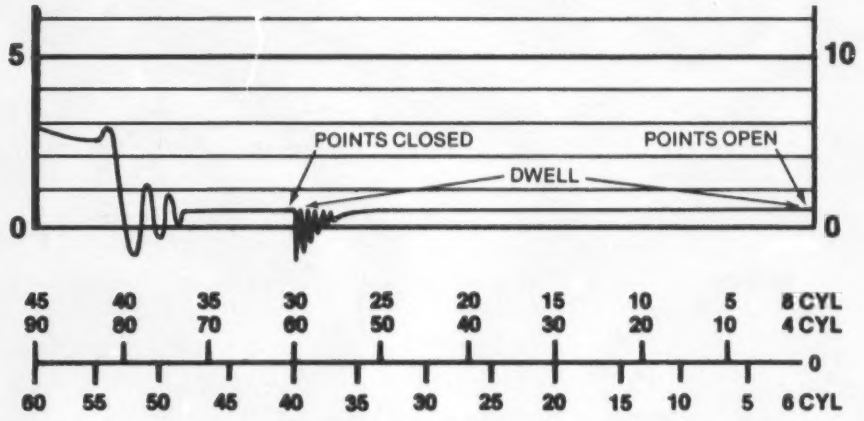
When both loose and/or corroded connections are indicated on the scope, wiggle the primary wires and look for pattern changes. This is one way to find the particular wire, connection, or terminal at fault.

Dwell and dwell variation test. You can measure dwell on the scope by using the proper scale at the bottom of the scope screen (8-cylinder, 4-cylinder, 6-cylinder).

The dwell section begins when the contact points close and stop when the points open. Normally, when the contact points close, the pattern shows a short, downward line followed by a series of oscillations. The normal point open signal is seen as a clean, sharp vertical rise from the zero line (see Figure 13-48).

Figure 13-48 Dwell section begins when points close and stops when points open



STEP 1 Adjust the circuit selector for the desired pattern. (Either secondary or primary can be used.)

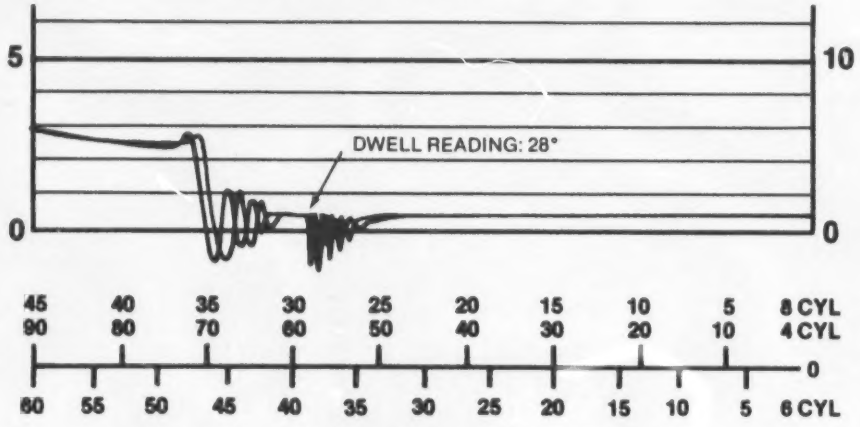
STEP 2 Turn the ***pattern selector*** knob to the superimposed position.

STEP 3 Lower the superimposed pattern until it rests on the correct dwell scale. This will provide a more accurate reading.

STEP 4 Compare the length of the dwell section with the dwell scale. Be sure to read the scale that applies to the size of the engine you're testing.

In Figure 13-49, the secondary, superimposed pattern was selected. The dwell reading is 28 degrees for an 8-cylinder engine.

Figure 13-49 Dwell reading is 28° on secondary, superimposed pattern



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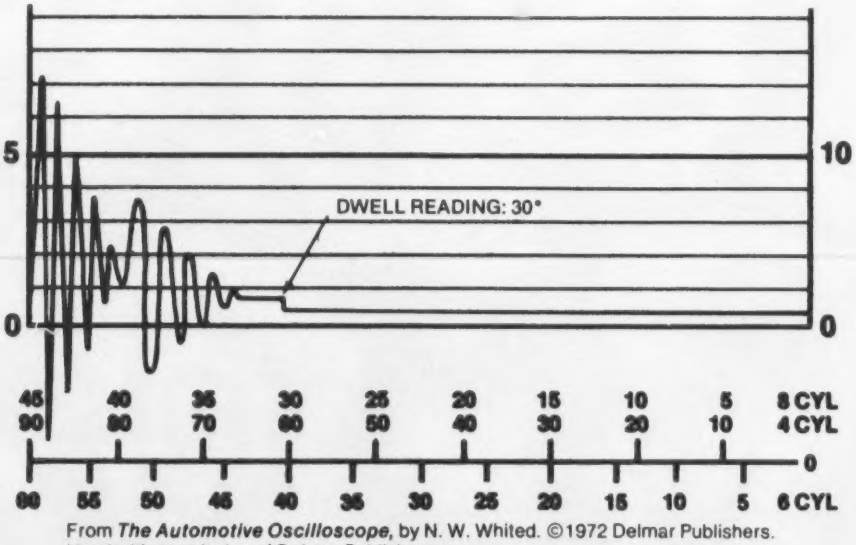
In Figure 13-50, the primary pattern was selected. The dwell reading is 30 degrees for an 8-cylinder engine.

The dwell reading is ***good*** if it is within vehicle manufacturer's specifications. In other words, the contact points are spaced properly.

The dwell reading is ***bad*** if it is not within manufacturer's specifications. This indicates improper point gap.

Figure 13-50 Dwell reading is 30° on primary, superimposed pattern



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Dwell variation is tested by noting any dwell change as the engine is operated at different speeds.

STEP 1 Disconnect the distributor vacuum line. Read the dwell reading at idle. Write down the results.

STEP 2 Operate the engine at 2,000 RPM. Note the dwell and write it down.

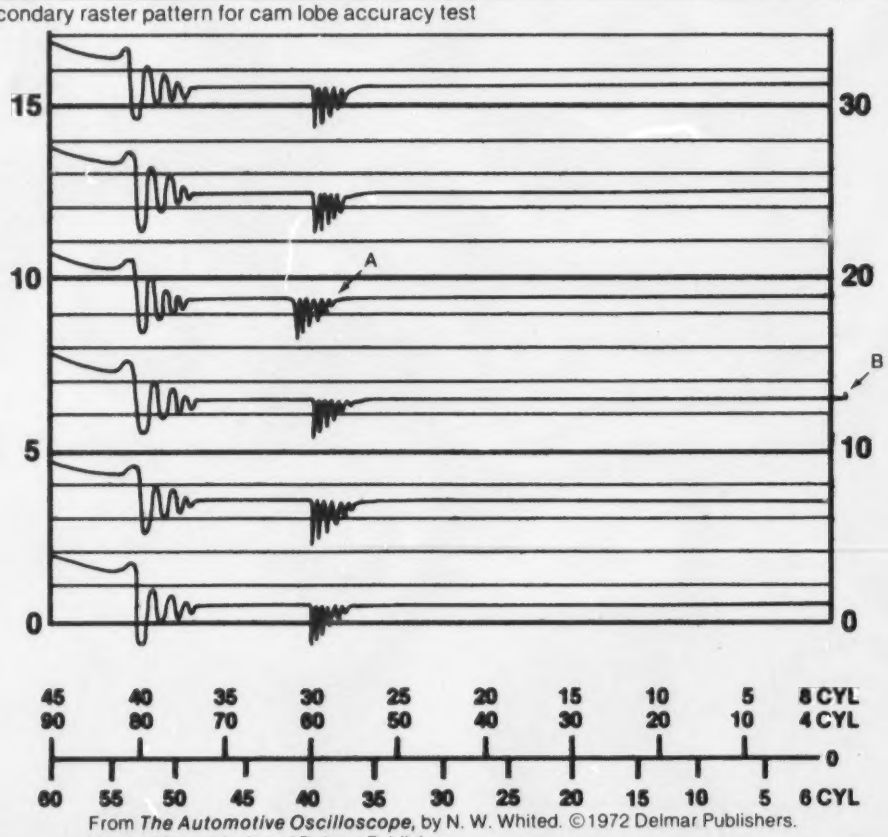
STEP 3 Reconnect the distributor vacuum line.

Dwell variation is *good* if it is within manufacturer's specifications. The distributor is in sound mechanical condition.

Dwell variation is *bad* if it is more than the manufacturer's specifications. This means that the distributor has a worn shaft and bushings or a worn breaker plate assembly.

Cam lobe accuracy test. To do a cam lobe accuracy test, use either the superimposed or raster pattern selection. However, the secondary raster pattern is better for singling out one cam lobe that is bad.

Figure 13-51 Secondary raster pattern for cam lobe accuracy test



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STEP 1 Turn the *pattern selector* knob to the raster pattern.

STEP 2 Operate the engine at approximately 1,000 RPM.

STEP 3 Look at both the point opening and the point close signals. In Figure 13-51, Point A shows the same cylinder out of alignment with the other cylinders. Point B shows that the point open signal is out of alignment with the other cylinder point open signals.

Cam lobes are *good* if both point close and point open signals are in alignment (within 2 degrees) with all other cylinders.

Cam lobes are *bad* if there is more than 2 degrees difference between point openings. This indicates a worn distributor cam lobe or distributor drive problems. The distributor should be removed and tested on a distributor tester.

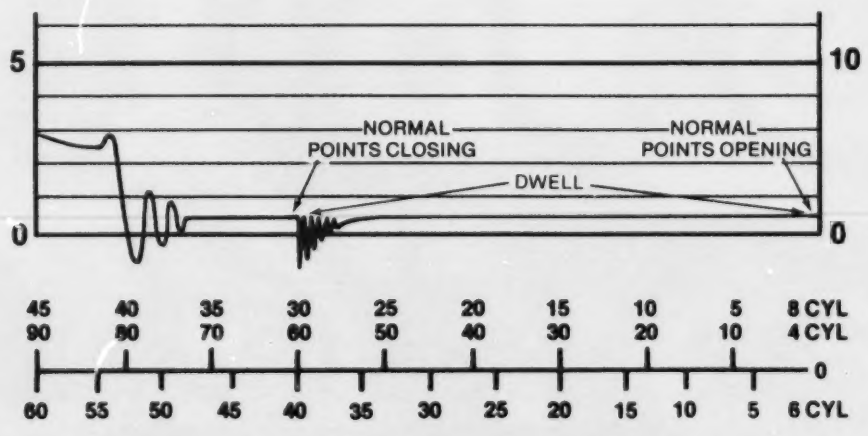
Contact point condition and action test. To analyze point condition and point action, the secondary raster pattern selection is used. You'll be looking at the dwell section.

Normally, when the points close, the pattern shows a short, downward line followed by a series of smaller and fewer oscillations. The point open signal is shown by a clean, sharp, upward line.

STEP 1 Turn the *pattern selector* knob to the *raster* pattern.

STEP 2 With the engine at idle RPM, look at the dwell section for point open and point close signals, as shown in Figure 13-52.

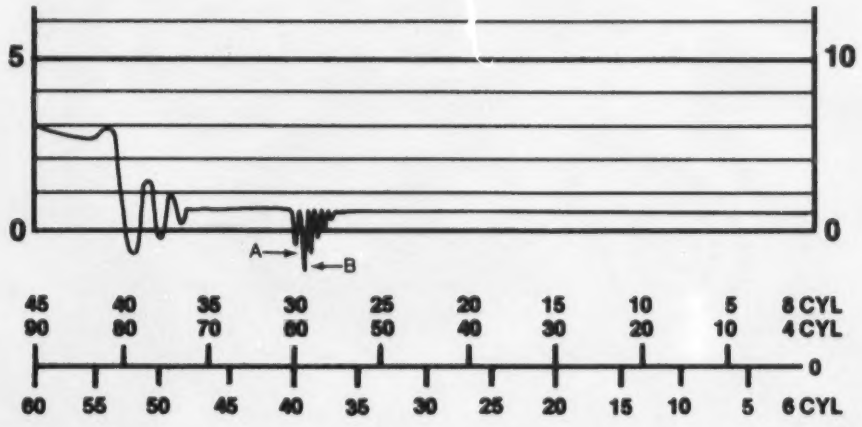
Figure 13-52 Secondary raster pattern shows normal point closing and opening signals



The points are *good* if the pattern shows normal point closing and point opening signals.

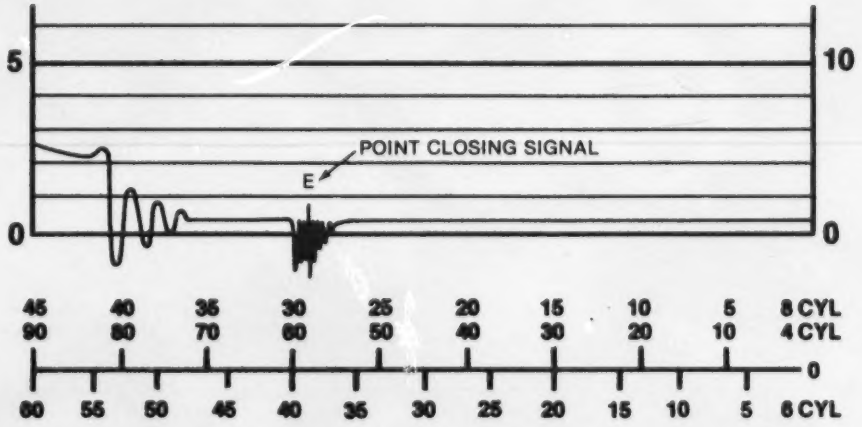
The points are ***bad*** if the pattern does not show normal opening and closing signals. Figure 13-53 is an example of a pattern showing contact points that are dirty, burned, or misaligned.

Figure 13-53 Closing signal is not normal: points are dirty, burned, or misaligned



You should notice that when the points close, the first oscillation (Point A) is the shortest, and the second oscillation (Point B) is the longest. This means that when the points first close, something keeps them from completely seating; however, by the time of the second oscillation they are seated.

Figure 13-54 Closing signal is not normal: point bounce due to weak spring tension



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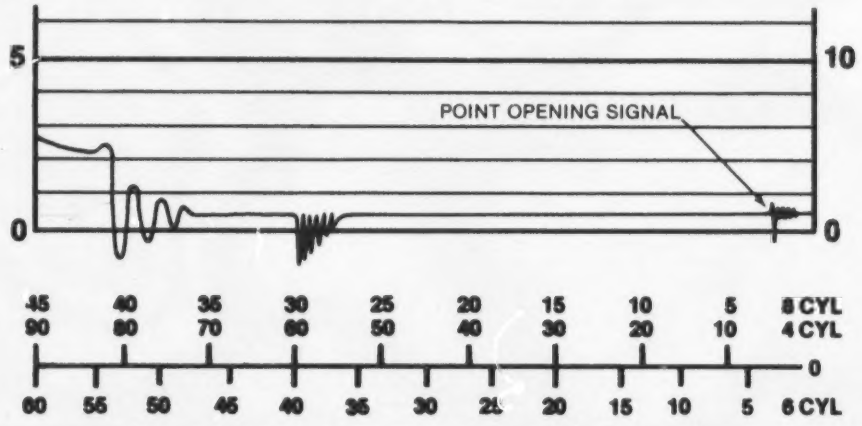
The points are also *bad* if the closing signal looks like the one in Figure 13-54. This is an example of weak spring tension of the contact points.

Look at the point close signal in Figure 13-54. You'll notice an upward line within the oscillation series. This means that at Point E there is a rise in voltage. This results only if the coil is firing. Since the coil is firing during the ***point close signal,*** it is likely that the points are not being closed tightly enough because of weak point spring tension. Point bounce will also show as an upward line following the first point closing downward line.

Figure 13-55 Opening signal is not normal: points are dirty or pitted, or condenser is bad

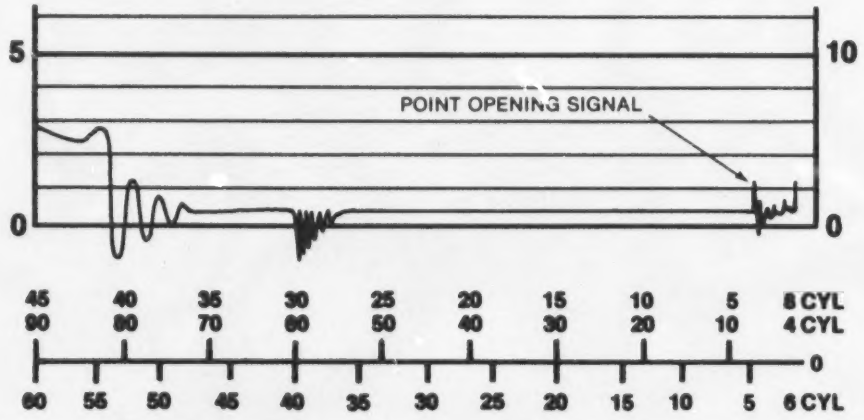


Contact points are also *bad* if the point opening signal looks like the one in Figure 13-55. Points are dirty or pitted, or the condenser is bad.

Look at the point opening signal in Figure 13-55. You'll notice a few small oscillations. Instead, there should be a clean, sharp break in the points, shown by a single, upward line. If the pattern shows that the points are dirty, burned, misaligned, weak in spring tension, bouncing, pitted, or arcing, then you should visually inspect the points and test the condenser.

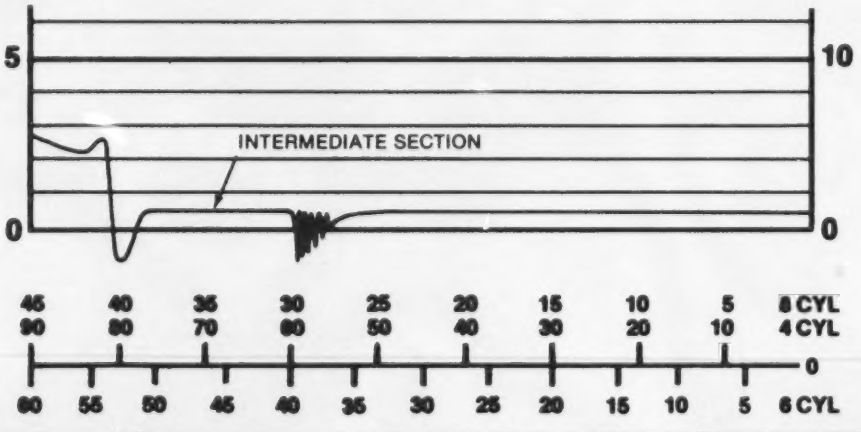
Coil and condenser condition test. Using the secondary raster pattern, put the engine at idle RPM and look at the points open signal again. You may see a ***step,*** or upward line, and a few small oscillations before it finally turns upward at the points open signal, as shown in Figure 13-56. This means the condenser is not working properly.

Figure 13-56 Pattern shows condenser is not working properly



Using the same secondary raster pattern, look at the intermediate section (see Figure 13-57). You may see a complete lack of oscillations where the remaining secondary voltage in the system should be oscillating from the coil to the condenser. This intermediate section is not normal. It indicates a faulty coil or condenser.

Figure 13-57 Intermediate section is not normal: faulty coil or condenser



To find out which part (coil or condenser) is not working properly, first look at the point open signal to determine condenser action. If the point open signal is normal, you'll need to check the coil.

Distributor condition tests. To diagnose distributor conditions and variations, you'll need to select the secondary, superimposed pattern.

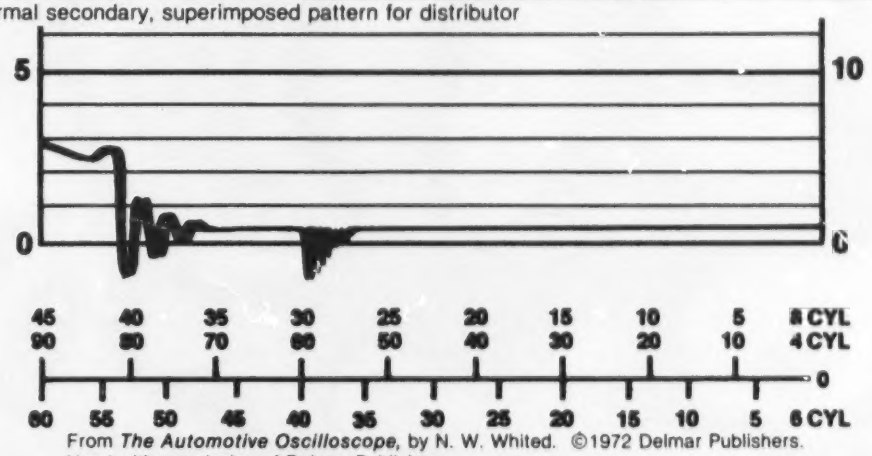
STEP 1 Turn the *pattern selector* knob to the *superimposed* position.

STEP 2 Disconnect the vacuum hose to the distributor advance unit before running this test.

STEP 3 Operate the engine at 1,000 RPM.

STEP 4 Look at the dwell section.

Figure 13-58 Normal secondary, superimposed pattern for distributor



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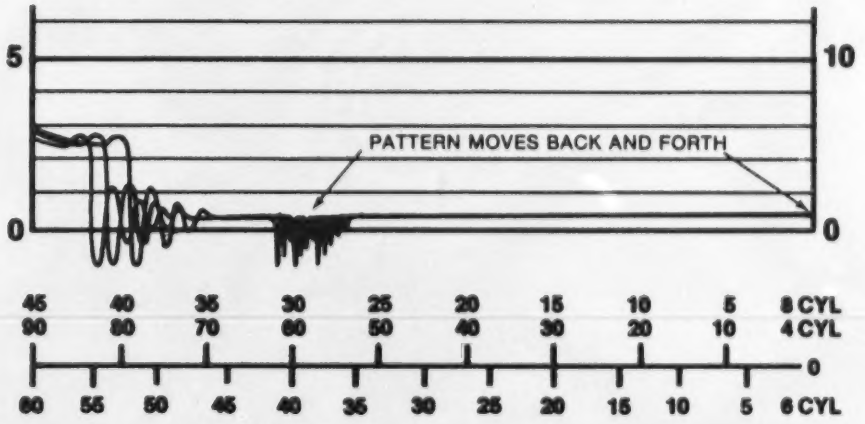
The pattern is *good* if it looks like the one in Figure 13-58.

Figure 13-59 Pattern indicates distributor variation



The pattern is *bad* if it moves back and forth. Figure 13-59 is an example of distributor variation.

If the distributor shaft is bent, or the cam lobes are worn, or the bushings are worn, or the breaker plate is loose, then the points will close at different times. Worn parts will cause the

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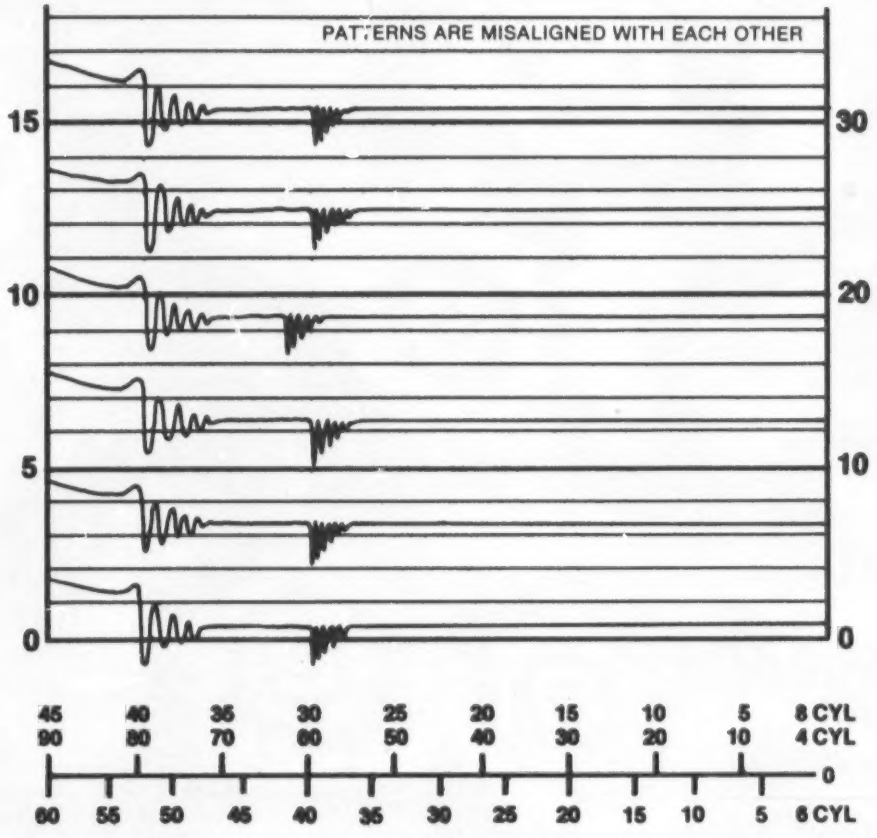
points to open or close at shorter or longer intervals. This makes the pattern move back and forth.

To check for a bent distributor shaft, select the secondary *raster* pattern.

If the distributor shaft is bent, a curved effect will appear in all the patterns, as shown in Figure 15-60. You will notice it particularly at the point close and point open areas. This is caused when points open sooner than normal on one side of the shaft, and later than normal on the other.

Figure 13-60 Patterns not in line indicate bent distributor shaft



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STEP 5 Stop engine and reinstall the vacuum hose.

Turn to your Review Exercise Book and complete Exercise 27.

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WORK ACTIVITY

Do not begin this work activity until you have your instructor's approval. If you have any difficulty, review the pages listed next to the work activity. If you still have difficulty, ask your instructor for help.

24. Using a scope, test the primary ignition circuit of an engine. Write down your results. (pages 188-202)

	GOOD	BAD
Cranking coil output	☐	☐
Reversed polarity	☐	☐
Loose primary lead	☐	☐
Loose primary connection	☐	☐
Dwell and dwell variation	☐	☐
Cam lobe accuracy	☐	☐
Contact point condition	☐	☐
Coil and condenser	☐	☐
Distributor condition	☐	☐

Check your work with your instructor.

When you have finished this activity, ask your instructor to return your pretest on Performance Objective 13. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will then tell you if you are ready to be checked off on the performance checklist or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

PERFORMANCE OBJECTIVE 14

REMOVE AND INSTALL THE COIL

INTRODUCTION TO P.O. 14

In this performance objective, you'll learn how to remove and install a coil.

You may find it helpful to review Performance Objective 13. There you'll find information on the use of the voltmeter and the scope for testing coils.

After you have finished all the work activities for Performance Objective 14, your instructor will use a checklist like the one below to evaluate your work.

Performance Checklist—P.O. 14

The instructor will provide either a live vehicle or a live engine. Remove and install the coil of the primary circuit. All of the performances below must be accomplished.

Student Performances

1. Removes and marks leads to coil.
2. Removes bracket and coil.
3. Checks manufacturer's specifications for replacement coil.
4. Installs coil and attaches leads.
5. Tests coil draw and resistance.
6. Tests primary circuit with scope.
7. Reports any defects in coil function.
8. Uses proper tools and equipment.
9. Follows all appropriate safety precautions.
10. Performs tasks in an appropriate amount of time.

Instructor Ratings

Acceptable	Not Acceptable	Omit

SAMPLE

Tools and Equipment

For this objective, you will need to use the tools and equipment listed below. You will be given the procedures for using special tools and equipment as you work through the activities.

Basic Hand Tool Set

Basic Equipment

fender covers
extension light
ammeter
ohmmeter

Special Equipment

oscilloscope

Reading List

If you would like additional information as you work through this performance objective, use the reference below.

General Reference

Stockel, *Auto Service and Repair,* pp. (21-5)-(21-6).

Personal and Service Safety Practices

Safety When Working around a Coil

Fender covers. Always use fender covers when doing work under the hood. This will keep the fenders from getting scratched.

Tools. Always use the right tools when removing and installing terminal lead connections. This will avoid rounding-over the terminal nuts and/or damaging the lead connections.

Polarity. Always connect the coil primary leads to their proper terminals to maintain correct ignition polarity.

Safety When Making Electrical Tests

Procedures. Follow the test equipment manufacturer's procedures.

Personal safety. Never do any electrical tests when standing on a wet floor surface or when vehicle or engine parts are wet. A painful shock can result.

Safety in Work Clothing and Grooming

Metal. Avoid wearing any metal (rings, buckles, wristwatches, necklaces) that might come in contact with an electrical part. You can receive a severe burn.

Loose clothing. Avoid wearing loose clothing or anything that can hang down and get caught by moving parts. Injury can result.

Hair. Keep hair away from moving parts. If your hair hangs below your collar, wear a hat.

REMOVING AND INSTALLING THE COIL

Removing and installing a coil is an easy job. However, there are several important points you need to know to do the operation quickly and correctly.

You'll find the coil in one of several locations, depending upon the vehicle make, model, and year. Also, coils may be installed in different positions (vertically, horizontally, and upside down). However, all coils are located near the ignition distributor (see Figure 14-1).

Figure 14-1 Coil location

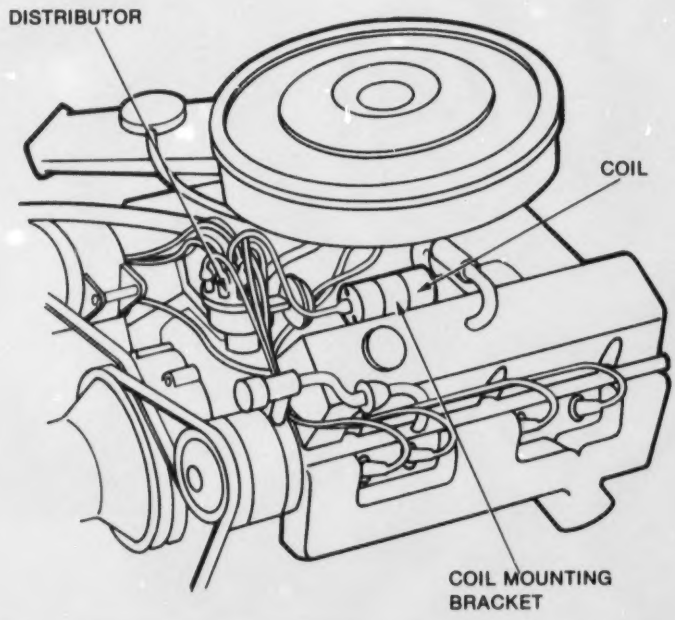
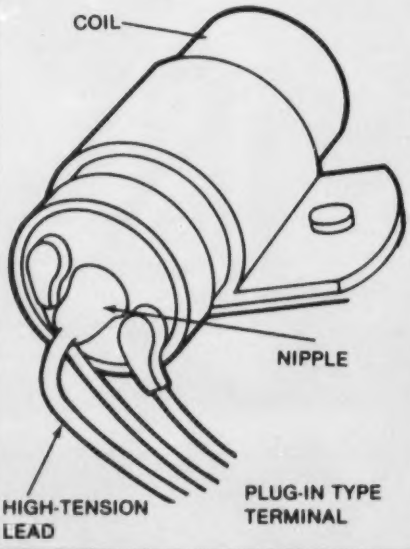


Figure 14-2 Remove the high-tension lead



Removing the Coil

STEP 1 Remove the coil high-tension lead from the center tower (see Figure 14-2).

- Break the lead nipple loose from the coil tower.
- Pull back the nipple, and at the same time, pull the high-tension lead straight out and away from the coil.

STEP 2 Remove both primary ignition leads from the coil terminal.

Some terminals are threaded and use standard hex nuts and lock washers to secure the leads. The nuts are removed with a shank driver and socket, as shown in Figure 14-3.

Figure 14-4 Location of coil part number

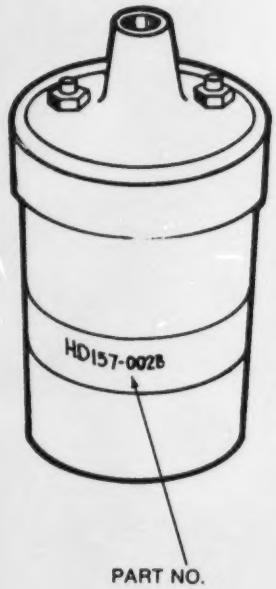


Figure 14-5 Slide coil into mounting bracket

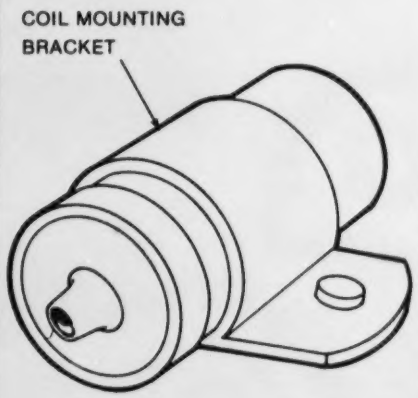
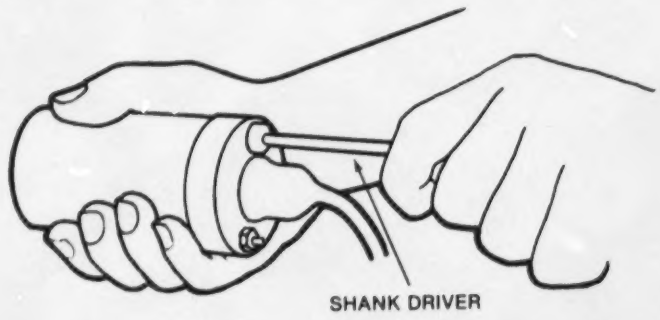


Figure 14-3 Removing primary leads with a shank driver and socket



NOTE: Some primary ignition leads have metal connectors that press over terminal studs on the coil. To remove them, break the dust boots loose. Grasp the boot and connector, and pull out and away from the coil.

CAUTION: Be sure you mark one primary lead so you will know which coil terminal it attaches to. Use a piece of masking tape and mark it NEG (−), POS (+), DIST, or BAT (the marking that appears on the coil terminal it is connected to).

STEP 3 Remove the mounting bolt(s) that secure the coil bracket and the coil to its mounting. Remove the coil and bracket from the mounting. Slide the coil out of the bracket.

Installing the Coil

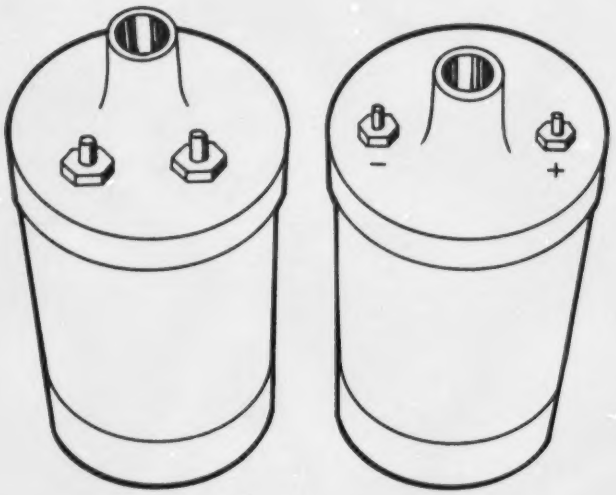
Before installing the new coil, be sure that it is the right one for the vehicle make, model, year, and engine size. Check the part number on the coil and compare it with the part number in the catalog listing (see Figure 14-4).

STEP 1 Slide the coil into the mounting bracket, as shown in Figure 14-5. Rotate the coil until the terminals are in the same position as when the coil is mounted in the vehicle.

REMEMBER: In their natural routing, the primary leads must line up with the coil terminals to maintain correct polarity in the ignition system.

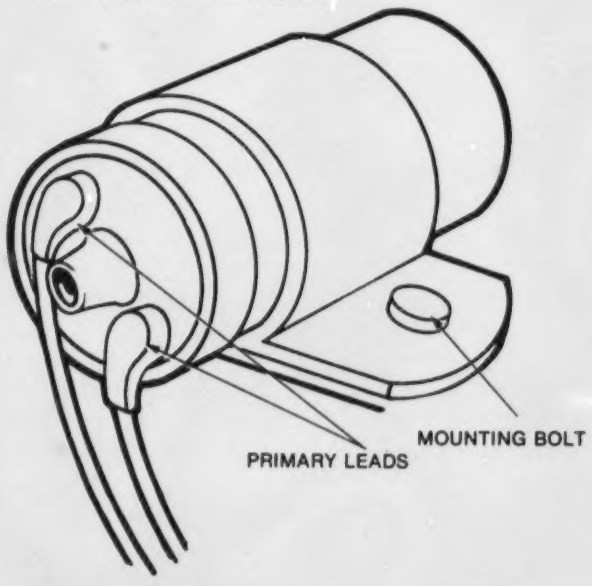
Some coil terminals are marked BAT and DIST, some are marked (−) and (+) (see Figure 14-6), and some are marked NEG and POS. However, all coil terminals indicate that the primary lead from the ***battery*** must be attached to the BAT, (+), or POS coil terminal; and the coil-to-distributor primary lead must be attached to the DIST, (−), or NEG coil terminal.

Figure 14-6 Two types of coil terminal markings



STEP 2 Place the coil and bracket on its mounting in the engine compartment. Install the mounting bolt(s) and tighten securely (see Figure 14-7).

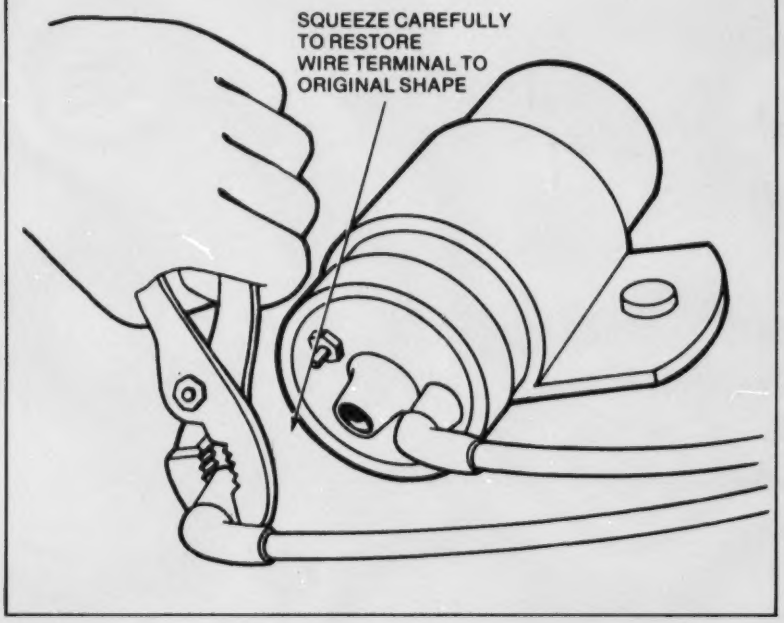
Figure 14-7 Remount the coil and bracket



STEP 3 Connect the primary ignition leads to the correct coil terminals. Tighten them securely so that they make a good, tight, electrical connection. Make sure the terminals are free of dirt and corrosion.

If metal, press-in connectors are used, check them for looseness on the terminals. If the connectors are loose, remove them from the coil terminals and squeeze them together a little to tighten, as shown in Figure 14-8.

Figure 14-8 Metal, press-in connectors



Reinstall the leads and check for tightness again. Repeat adjustments until there are good, tight connections on the coil terminals.

STEP 4 Check the metal terminal end of the high-tension lead to be sure it fits tightly on the lead. Also, clean the terminals to remove any corrosion buildup.

STEP 5 Put the coil high-tension lead into the center tower of the coil. Be sure the lead is pushed all the way in and that the nipple is all the way down around the tower.

MAKING AN OPERATIONAL CHECK OF THE COIL

After you have installed the new coil, you need to make operational tests on the coil and primary ignition system. These tests will tell you if:

(1) the coil is functioning properly and meets manufacturer's specifications

(2) the coil has been installed properly, having the right electrical polarity

(3) there are additional faults in the primary ignition system that need correcting

Coil Draw, Coil Primary Resistance, and Coil Secondary Resistance Tests

Look up the manufacturer's specifications for coil draw, coil primary resistance, and coil secondary resistance in your technical service manual. Then perform the coil draw, coil primary resistance, and coil secondary resistance tests (see Performance Objective 13).

If the new coil does not meet the manufacturer's specifications, recheck the part number to be sure that the right coil has been installed. If the part number is correct, replace the coil with another coil that has the same part number.

If the coil does meet the manufacturer's specifications, test the primary ignition circuit to be sure all faults have been corrected.

Primary Ignition Circuit Tests with a Scope

If you need to review the testing procedures and the use of an oscilloscope, refer to Performance Objective 13.

Turn to your Review Exercise Book and complete Exercise 28.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

1. Look up the part number of the ignition coil in a parts catalog. Write down the number. (pages 000-000)

2. Remove and install the ignition coil. (pages 209-213)

3. Test the coil for current draw, coil primary resistance, and coil secondary resistance. Write down your results. (page 213)

4. Using a scope, test the primary ignition circuit. Write down your results. (page 213) *Check your work with your instructor.*

When you have finished these activities, ask your instructor to return your pretest on Performance Objective 14. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will then tell you if you are ready to be checked off on the performance checklist or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.

PERFORMANCE OBJECTIVE 15

REMOVE AND INSTALL THE IGNITION SWITCH AND RESISTOR

INTRODUCTION TO P.O. 15

In this performance objective, you'll learn how to remove and install an ignition switch and ignition resistors.

You may find it helpful to review Performance Objective 13. There you'll find information on making operational checks and tests on ignition switches and ignition resistors.

After you have finished all the work activities for Performance Objective 15, your instructor will use a checklist like the one below to evaluate your work.

Performance Checklist—P.O. 15

The instructor will provide either a live vehicle or a shop vehicle. Remove and install the ignition switch and resistor. All of the performances below must be accomplished.

Student Performances

Instructor Ratings

Student Performances	Acceptable	Not Acceptable	Omit
*1. a. Removes a dash-type ignition switch.			
b. Installs a dash-type ignition switch.			
c. Makes an operational check of the switch.			
*2. a. Removes a steering-column ignition switch.			
b. Installs a steering-column ignition switch.			
c. Makes an operational check of the switch.			
3. Removes an ignition resistor (wire or ballast).			
4. Tests an ignition resistor.			
5. Installs an ignition resistor.			
6. Makes an operational check of an ignition switch resistor.			
7. Uses proper tools and equipment.			
8. Follows all appropriate safety precautions.			
9. Performs tasks in an acceptable amount of time.			

SAMPLE

*The instructor may choose to delete either Item 1 or 2 if performance of both is felt to be unnecessary.

Tools and Equipment

For this objective, you will need to use the tools and equipment listed below. You will be given the procedures for using special tools and equipment as you work through the activities.

Basic Hand Tool Set

Special-Purpose Hand Tools

ignition switch tools, as needed

Basic Equipment

fender covers
seat covers
voltmeter
ohmmeter
extension light

Safety Equipment

eye protection

Reading List

If you would like additional information as you work through this performance objective, use the references below.

General References

Crouse, *Automotive Mechanics,* pp. 308-9.

Crouse, *The Auto Book,* pp. 278-81.

Special-Purpose Reference

Crouse, *Automotive Electrical Equipment,* pp. 195-96.

Personal and Service Safety Practices

Safety When Working around an Ignition Switch

Seat cover. Always use a seat cover when working inside the vehicle. This will keep the seats from becoming soiled.

Cleanliness. Always work with clean hands and tools. This will keep the ignition terminals and parts clean, as well as the vehicle steering wheel and dash.

Terminals. Make sure that the various wires (leads) are connected to the appropriate switch terminals. Crossing wires can damage electrical parts.

Safety When Working around a Resistor

Fender covers. Always use fender covers when doing work under the hood.

Battery ground cable. Always disconnect the battery ground cable when working on a resistor, particularly the resistance-wire type. This will keep you from accidentally damaging the ignition switch or resistor wire while connecting it.

Safety When Making an Electrical Test

Procedures. Follow the electrical test equipment manufacturer's procedures.

Personal safety. Never do any electrical tests when standing on a wet floor or surface, or when the vehicle or parts are wet. A painful shock can result.

Safety In Work Clothing and Grooming

Metal. Avoid wearing any metal (rings, buckles, wristwatches, necklaces) that might come in contact with an electrical part. You can receive a severe burn.

Loose clothing. Avoid wearing loose clothing or anything that could get caught in moving parts. Personal injury or damage to parts can result.

REMOVING AND INSTALLING THE IGNITION SWITCH

There are two basic types of ignition switches found on vehicles. One is the ***dash-type*** switch, which is located and mounted on the instrument dash panel of the vehicle. Until 1970, the dash-type ignition switch was used in all vehicles.

The other type of ignition switch is the ***steering-column***-type, which is located and mounted on the steering column. This type of switch is currently used and has been popular since 1970.

Dash Ignition Switch

Removing the switch. The dash ignition switch is generally located below, and to the right of, the instruments on the dash panel, as shown in Figure 15-1.

Figure 15-1 Location of dash-type ignition switch

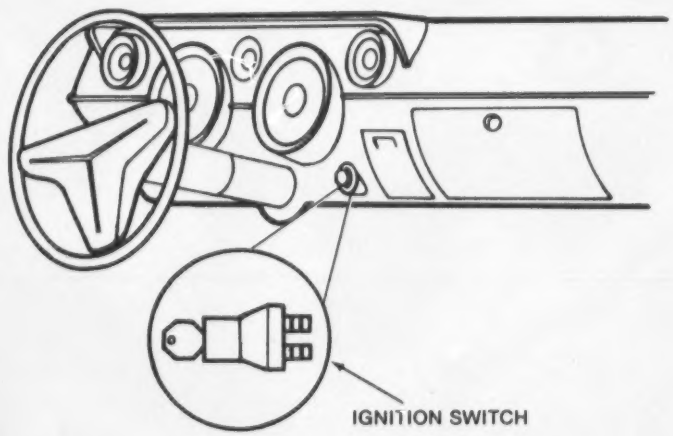
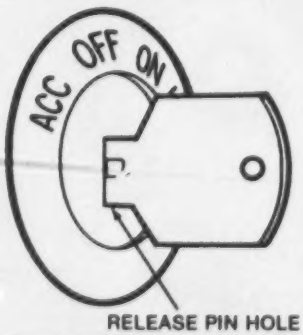


Figure 15-2 Location of release pin hole



Generally, most dash-type ignition switches are removed by the following procedures:

STEP 1 Disconnect the battery ground cable.

STEP 2 Remove the lock cylinder.

- Turn the ignition key to the ***off*** position. (Some switches specify the ***accessory*** position.)
- Insert a wire (paper clip) into the small ***release pin hole*** located in the cylinder face (see Figure 15-2).
- While pushing in on the wire, continue to turn the cylinder (ignition key) counterclockwise (left), and pull the cylinder from the case.

(Ignition switches are supplied by automotive part stores without the key or lock. This allows you to replace the switch and still reuse the lock and key.)

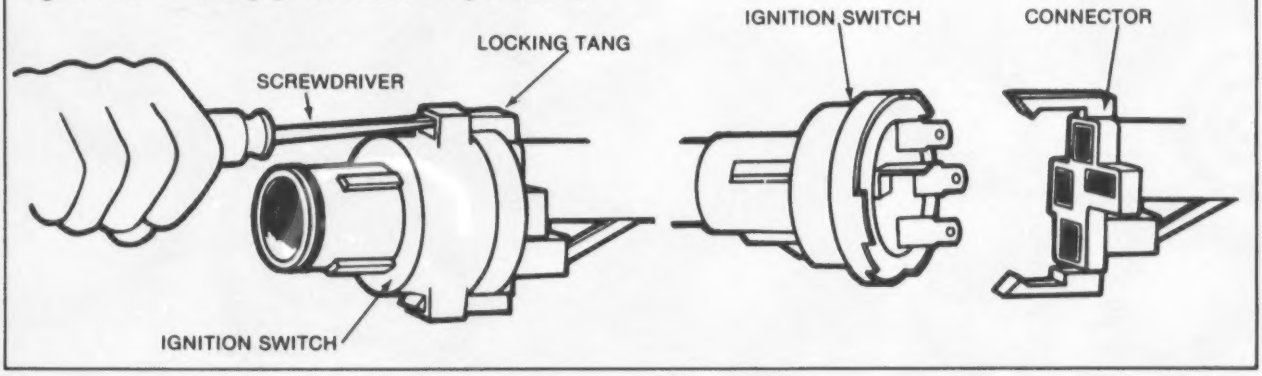
STEP 3 Remove the ignition switch mounting nut on the passenger side of the ignition switch.

STEP 4 Remove the ignition switch from back of the dash.

STEP 5 Remove the ignition switch wiring connector.

- With a screwdriver, depress the locking tangs and separate the connector, as shown in Figure 15-3. Check the connector and the switch for possible corrosion and for burned-out terminals in the connector.

Figure 15-3 Removing ignition switch wiring connector



Installing the switch. Follow the removal procedures, but reverse the order. Attach the connector to the ignition switch.

Insert the switch into the dash opening; tighten the mounting nuts; and install the lock cylinder. Then, reconnect the battery ground cable.

CAUTION: Be sure the ignition switch connector is installed securely into the switch.

Making an operational check. There are two simple checks you can make on the ignition switch to find out if it's operating correctly.

(1) Turn the key to different positions (ACC, ON, and START) and check its operation in each position.

(2) Connect the voltmeter to the primary circuit and check for a voltage drop or too much resistance in the switch.

Turn to your Review Exercise Book and complete Exercise 29.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

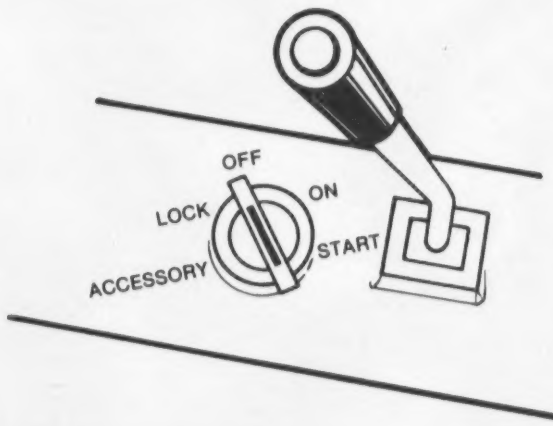
1. **Remove and install a dash ignition switch. (pages 220-221)**
2. **Make an operational check of the dash ignition switch. (page 221)** *Check your work with your instructor.*

After you have finished these activities, go on to the next section.

Steering-Column Ignition Switch

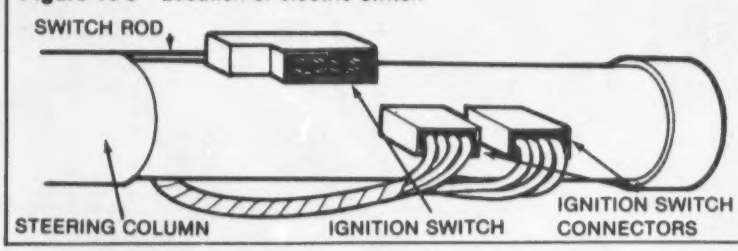
The ignition switch is located in the steering column on the right hand side just below the steering wheel, as shown in Figure 15-4.

Figure 15-4 Steering-column ignition switch



The electrical switching part of the assembly is separate from the key and lock cylinder. The ignition switch is located on the lower end of the steering column, as shown in Figure 15-5.

Figure 15-5 Location of electric switch

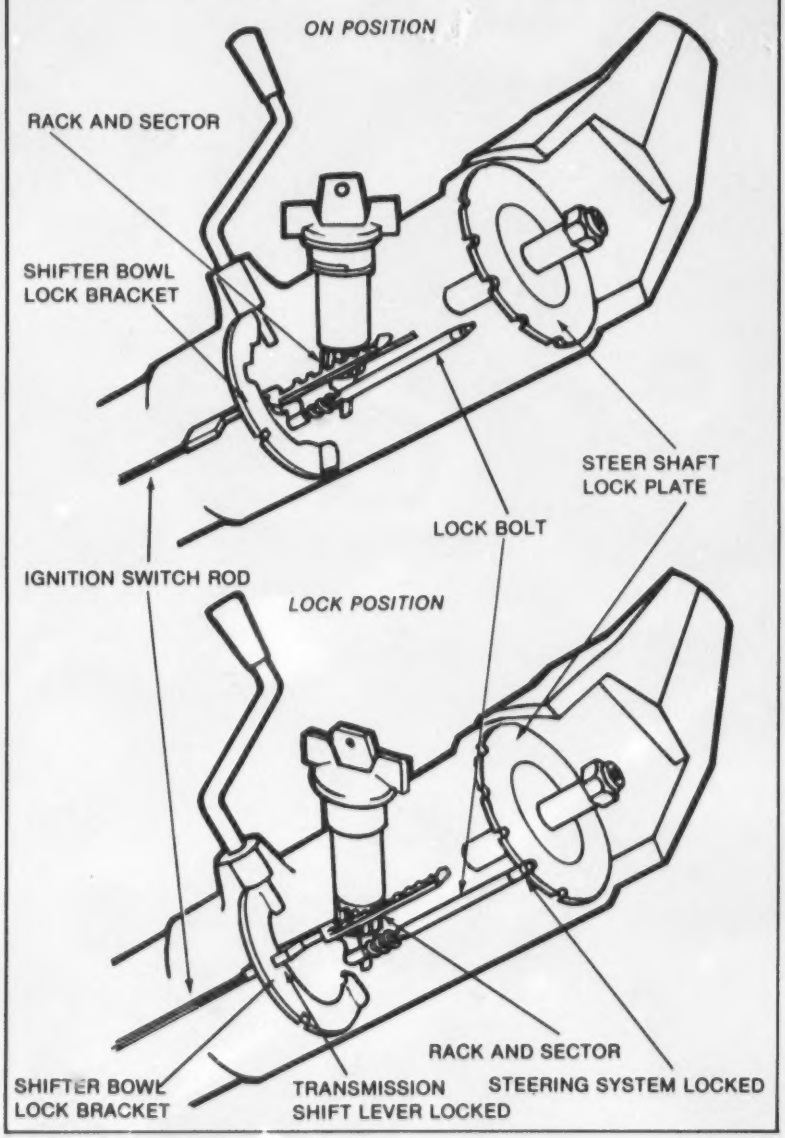


However, both work together through the action of the ignition switch rod, sometimes called an *actuator rod.*

The ignition switch rod outside the steering column connects the electric ignition switch to the rack and sector assembly, as shown in Figure 15-6.

When the ignition key is turned, the movement of the switch rod selects the various ignition system circuits inside the switch housing.

Figure 15-6 Position of ignition switch rod in *lock* and *on* positions

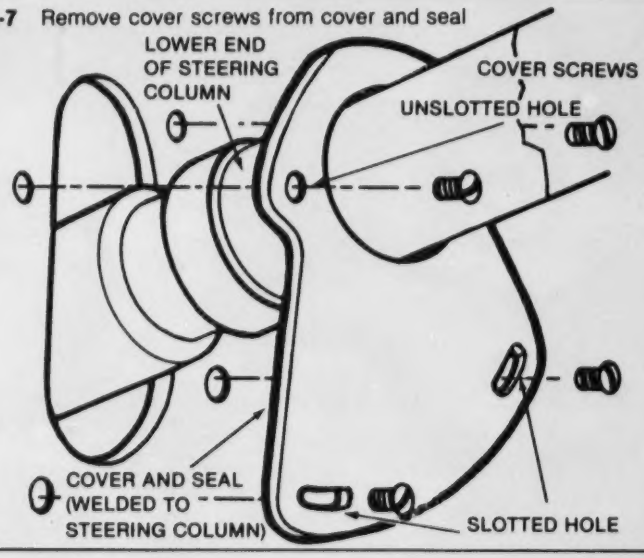


Removing the switch. Always refer to the vehicle manufacturer's removal and installation procedures for exact directions. You will find this information in your technical service manual.

STEP 1 Disconnect the battery ground cable.

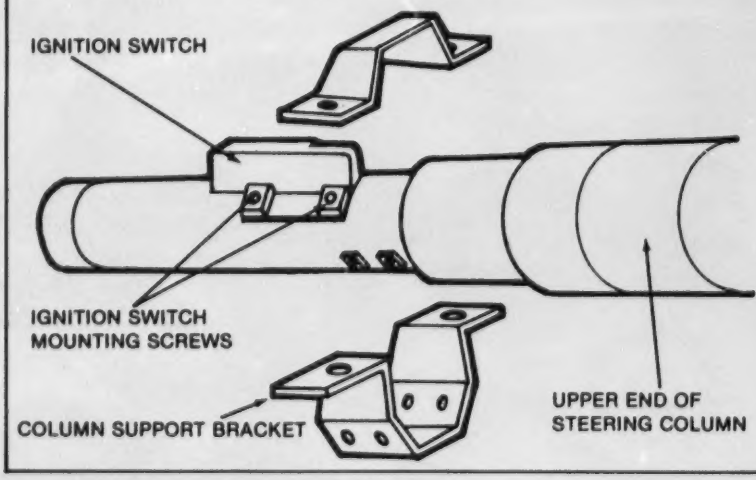
STEP 2 Remove the screws from the cover and seal at the lower end of the steering column, as shown in Figure 15-7.

Figure 15-7 Remove cover screws from cover and seal



STEP 3 Remove the column support bracket and attaching bolts, as shown in Figure 15-8.

Figure 15-8 Removing column support bracket



STEP 4 Lower the steering column so that the steering wheel is resting on the seat. Disconnect the ignition switch connector(s) (see Figure 15-5).

STEP 5 Remove the ignition switch attaching screws and remove the switch.

Installing the switch.

STEP 1 Turn the ignition key to the *lock* position.

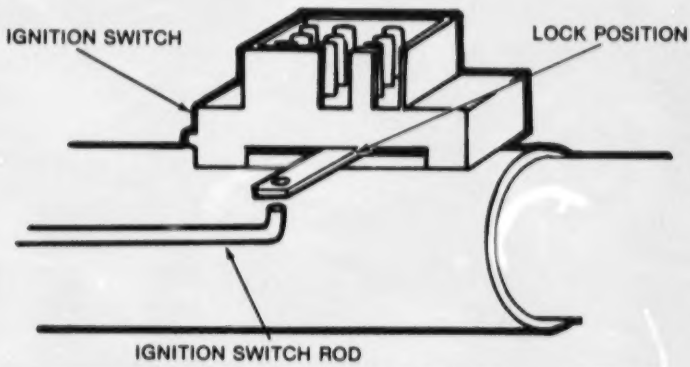
STEP 2 Hold the ignition switch on the steering column over its mounting location.

STEP 3 Move the ignition switch to the *lock* position.

STEP 4 Install the rod into the hole on the end of the lever, as shown in Figure 15-9.

STEP 5 Mount the ignition switch to the column with the mounting screws.

Figure 15-9 Installing ignition switch rod into ignition switch



The remaining installation steps for the column-type switch are in reverse order of the removal procedures.

STEP 1 Reinstall the ignition switch mounting bolts.

STEP 2 Reconnect the ignition connectors.

STEP 3 Reinstall the column support bracket and attach the column cover and seal at the lower end.

STEP 4 Reinstall the battery ground cable to the battery post.

CAUTION: Be sure the ignition switch connector(s) are installed securely into the ignition switch.

Making an operational check. There are two simple checks that you can make on the ignition switch to find out if it is operating correctly.

(1) Turn the key to the different positions (ACC, RUN, and START) and check its operation.

(2) Connect the voltmeter to the primary circuit and check for voltage drop or too much resistance in the switch. For test procedures, refer to Performance Objective 13.

Turn to your Review Exercise Book and complete Exercise 30.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

3. Remove and install a steering-column ignition switch. (pages 222-226)

4. Make an operational check of the steering-column ignition switch. *Check your work with your instructor.*

After you have finished these activities, go on to the next section.

REMOVING AND INSTALLING THE IGNITION RESISTOR

There are two types of resistors on ignition systems. One is a ***ballast resistor*** and the other is a ***resistance wire.*** They both serve the same functions: (1) reducing voltage to the coil and points in order to cut down contact point arcing and burning when the engine is operating, and (2) providing a good hot spark while starting. Both resistors are calibrated to definite resistance (ohms) values by the vehicle manufacturer.

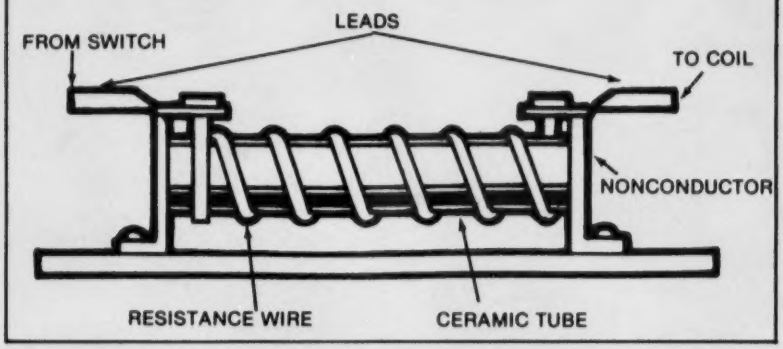
Removing the Resistor

Removing a ballast-type resistor. The ballast-type resistor is an external resistor located on or near the coil.

STEP 1 Disconnect the primary leads from each end of the resistor, as shown in Figure 15-10.

STEP 2 Remove the resistor mounting bolt and remove the resistor.

Figure 15-10 Ballast-type resistor leads

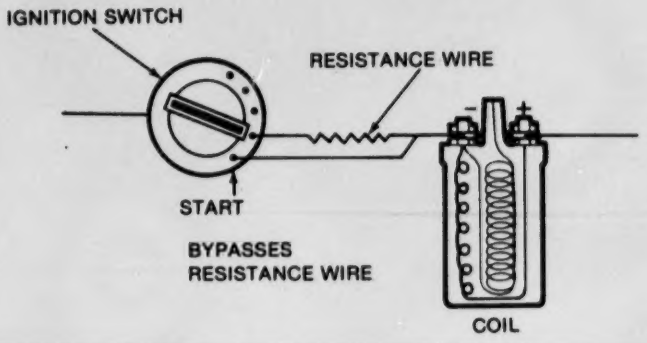


Removing a wire-type resistor. The wire-type resistor is an internal lead connecting the ignition switch to the coil. In most cases, it is housed inside the wiring harness.

STEP 1 Disconnect the ignition switch connector. Disconnect other connectors from the harness, as required.

STEP 2 Remove the resistance wire lead from the BAT or POS terminal of the coil (see Figure 15-11). Disconnect other leads of the ignition harness from their terminals.

Figure 15-11 Connections for wire-type resistor



STEP 3 Remove the engine ignition harness through the engine firewall.

Making an Operational Check

Before installing a new resistor (ballast or wire), look up the vehicle manufacturer's specifications (given in ohms resistance values). You'll find these specifications in your technical service manual. With an ohmmeter, test the new resistor before you install it to see if it meets the vehicle manufacturer's specifications.

Installing the Resistor

The procedures for installing a resistor (either ballast-type or resistance wire-type), are the same as the procedures for removing it, except the steps are in reverse order.

Installing a ballast-type resistor.

STEP 1 Install the resistor on its mounting and tighten the mounting bolt securely.

STEP 2 Connect the ignition switch primary lead to the terminal on the resistor.

STEP 3 Connect the coil primary lead on the terminal at the opposite end of the resistor.

Installing a resistance wire-type resistor.

STEP 1 Install the new wiring harness, with the resistance wire included, into the engine compartment and through the firewall.

STEP 2 Attach the harness connector at one end to the ignition switch connector.

STEP 3 Connect the resistance wire to the BAT or POS terminal of the coil.

STEP 4 Attach the other leads or connectors of the ignition harness to the terminals in the engine compartment.

NOTE: For the resistance wire-type resistor, some manufacturers recommend replacement of the entire engine ignition harness assembly.

Turn to your Review Exercise Book and complete Exercise 31.

WORK ACTIVITIES

Do not begin any of these work activities until you have your instructor's approval. If you have any difficulty, review the pages listed next to each work activity. If you still have difficulty, ask your instructor for help.

5. Remove and install a ballast-type resistor. (pages 227-228) *Check your work with your instructor.*

6. Remove and install a resistance wire-type resistor. (pages 228-229) *Check your work with your instructor.*

7. Test the resistance of a resistor by using an ohmmeter. Compare your results with the vehicle manufacturer's specifications. (Performance Objective 13) *Check your work with your instructor.*

When you have finished these activities, ask your instructor to return your pretest on Performance Objective 15. Complete the questions that you missed or were unable to answer the first time you took the pretest. Check your answers with your instructor when you finish. Your instructor will then tell you if you are ready to take the posttest or be checked off on the performance checklist, or if you need to correct some of your answers first.

If you are told by your instructor that you are ready for the performance checklist, carefully tear the checklist out of your Review Exercise Book and give it to your instructor.